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ABSTRACT

The Advanced Placement (AP) program is a cooperative educational effort of secondary schools, colleges, and the College Board that consists of 30 college-level courses and examinations in 17 academic disciplines for highly motivated students in secondary schools. AP courses are offered in more than 11,000 high schools and are recognized by nearly 2,900 U.S. and foreign colleges and universities that grant credit, advanced placement, or both to students who have performed satisfactorily on the AP examinations. The AP program provides teaching materials, course descriptions, and examinations based on these descriptions, but it does not prescribe the textbook, schedule of lessons, or teaching techniques. Examinations are administered in May, scored in June, and reported in July of each year. This booklet describes the AP program and its course and examination in Statistics. A topic outline, a discussion of the instructional emphasis of the AP Statistics course, some sample questions, other details about the Statistics examination, and some suggested resources for teaching AP statistics are presented. Information about test construction is also included. An order form for AP publications is attached. (SLD)

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ED 411 284

Advanced Placement Course Description

Statistics

May 1997, May 1998

The College Board
Educational Excellence for All Students

TM027 289

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Introduction

The Advanced Placement Program®

The Advanced Placement (AP) Program is a cooperative, educational endeavor of secondary schools, colleges, and the College Board. It consists of 30 college-level courses and examinations in 17 academic disciplines for highly motivated students in secondary schools. Many of these students report that they enjoy the challenge of the program; high school faculty find that AP courses greatly enhance students' confidence and academic interest; and college faculty find that these students are far better prepared for serious academic work. AP courses are offered in more than 11,000 high schools that are located in every state across the United States, in every province and territory in Canada, and in 63 other countries. They are recognized by nearly 2,900 United States and foreign colleges and universities, which grant credit, advanced placement, or both to students who have performed satisfactorily on AP Examinations. Approximately 1,200 institutions grant sophomore standing to students who have demonstrated their competence in three or more of these examinations.

The AP Program provides teaching materials, course descriptions, and examinations based on those descriptions. It does not, however, prescribe the textbook, schedule of lessons, or teaching techniques. The examination grade is sent to the colleges of the student's choice, which then grant credit, advanced placement, or both, depending on institutional policies.

The Course Descriptions

Currently, one or more course descriptions, examinations, and sets of curriculum materials are available for AP courses in art, biology, calculus, chemistry, computer science, economics, English, environmental science, French, German, government and politics, history, international English, Latin, music, physics, psychology, Spanish, and statistics. The examination in most of these subjects

covers the equivalent of a full-year college course. However, computer science A, environmental science, macroeconomics, microeconomics, government and politics–comparative, government and politics–U.S., physics C (electricity and magnetism), physics C (mechanics), psychology, and statistics are half-year courses. AP Statistics, the newest offering, is equivalent to an introductory noncalculus-based, college-level course typically taught in one semester.

Each course offering is under the aegis of a development committee made up of college faculty and AP teachers appointed by the College Board to overlapping three-year terms. The course descriptions, reviewed and published biennially, are regularly distributed to participating schools and colleges and are available for purchase. Although the course descriptions have been designed primarily for teachers, department heads, and curriculum coordinators, they can also serve as useful guides for students who wish to prepare for the examinations independently. In most subjects, the course descriptions are supplemented by a *Teacher's Guide to AP Courses*, a complete recent examination, and a description of how the exam was graded. (See the AP Publications Order Form included with this booklet.)

The Examinations

The AP Examinations—or, in Studio Art, evaluations—are offered throughout the world each May. (See the back cover for the date of the next examination.) No examination is longer than three hours; some are shorter. They are administered at participating schools or at multischool centers. (Any school may participate; it need only file the Advanced Placement Participation Form sent to all high schools every fall.) Except for Studio Art, which consists of a portfolio assessment, all examinations contain a free-response section (either essay or problem-solving) and another section consisting of multiple-choice questions. The modern language examinations also contain a performance section that includes the recording of student responses on audiotape.

The Reading

In June, the free-response portions of examinations and the portfolios in Studio Art are scored by more than 3,700 college and secondary schooi teachers who gather especially for this purpose and are directed by a chief faculty consultant in each field. Precautions are taken to ensure the fairness and reliability of the Reading. The chief faculty consultants—college professors who sit with the development committees—develop initial grading standards in consultation with their immediate assistants. The other faculty consultants then join in the determination of more detailed expectations. Quality and reliability of the faculty consultants' judgments are maintained through frequent reviews of these expectations, scoring of sample papers, rescoring of randomly selected examination books, deliberate obscuring of previous faculty consultants' scores as well as of the students' names and schools, and continuous monitoring of the faculty consultants' work by table leaders. Educational Testing Service (ETS) also conducts formal studies of the consistency of scores throughout the Reading.

The Grades

The chief faculty consultants bring the same standards that are applied in developing the examinations to the grading process. The multiple-choice questions are used to provide both high reliability (the likelihood that a candidate repeating the examination would receive the same grade) and continuity. They ensure that a candidate who earns a grade of 3 on one year's examination is at the same level of competence as candidates who earned the same grade in previous years.

The stability of grades in a program that publishes its essay or problem-solving questions, and hence must use new ones every year, is maintained in two ways. First, direct comparisons are made between the performance of the current year's candidates and that of former candidates on a set of identical multiple-choice questions. Psychometricians can then determine the relative diffi-

culty of the essay questions and calibrate them with a high degree of accuracy, thereby minimizing the effects on candidates' grades of different essay or problem-solving questions from one year to the next. The success of this procedure, of course, depends on the multiple-choice questions remaining secure. Second, the chief faculty consultants compare the general distributions of scores in their subject areas to those of the past several years and consider other pertinent data (such as validity studies and table leader reports) to arrive at decisions on grades.

The faculty consultants' judgments on the essay or problem-solving questions are combined with the results of scoring the multiple-choice questions, and the total raw scores are converted by the chief faculty consultants to the program's five-point scale:

5—extremely well qualified
4—well qualified
3—qualified
2—possibly qualified
1—no recommendation

The questions on the multiple-choice sections are scored with a correction factor to compensate for random guessing, and they are deliberately set at a specific level of difficulty such that students performing acceptably on the free-response section of an examination generally need to answer about 50 to 60 percent of the multiple-choice questions correctly to obtain a total grade of 3.

In July, the grades are reported to the students, their secondary schools, and the colleges they have selected. Students' essay booklets are available, at cost, to their designated colleges; if the booklets are not requested by the colleges, they then become available to the students' schools.

AP® Scholar Awards

The program offers a number of Advanced Placement Scholar Awards to recognize high school students who have demonstrated college-level achievement through AP courses and examinations. The calculation of the number of examinations needed to qualify for the awards differentiates between examinations that cover full-year and half-year college courses: results of exams corre-

sponding to half-year courses are given half the weight of results corresponding to full-year courses. (The half-year courses are identified on page ii.)

Students in the United States and Canada who receive grades of 3 or higher on AP Examinations for three or more full-year courses (or the equivalent number of half-year courses) receive AP Scholar Awards.

Students who receive grades of 3 or higher on AP Examinations for four or more full-year courses (or the equivalent number of half-year courses), with an average exam grade of 3.25, receive AP Scholar with Honor Awards.

Students who receive grades of 3 or higher on AP Examinations for five or more full-year courses (or the equivalent number of half-year courses), with an average exam grade of 3.5, receive AP Scholar with Distinction Awards.

Students in schools outside of the United States and Canada who meet these criteria are awarded an International AP Certificate.

In addition, the AP Program recognizes the male and female high school students in each state who have achieved the highest average grade on the greatest number of AP Examinations in their state that year. The governor of each state is invited to present these AP State Scholar Awards, and these presentations are occasionally public.

National AP Scholar Awards are granted to students who receive an average AP grade of 4 or higher on eight or more AP Examinations for full-year courses (or the equivalent number of half-year courses). In Canada, National AP Scholar Awards are granted to students with the highest AP grades on the greatest number of AP Examinations for full-year courses (or the equivalent number of half-year courses).

AP International Scholar Awards are granted to the male and female students who have achieved the highest average grades on the greatest number of AP Examinations for full-year courses (or the equivalent number of half-year courses).

AP Department of Defense Dependents Schools (DODDS) Scholar Awards are granted to the female and male students attending DODD schools who have achieved the highest average grades on the greatest number of AP Examinations for full-year

courses (or the equivalent number of half-year courses).

Award recipients and their schools are notified in the fall. Thereafter, grade transcripts requested by the students include the scholar designation.

AP International Diploma for Overseas Study

The Advanced Placement International Diploma (APID) certifies the achievement of successful AP candidates and is recognized at universities throughout the world. It accommodates any student, whether enrolled in a high school in the United States or abroad, whose higher education plans include applying to an overseas university.

To be eligible, a student must declare his or her candidacy at the time he or she takes Advanced Placement Examinations. The criteria include earning AP grades of 3 or higher on four full-year AP Examinations (or the equivalent number of half-year courses*) during the student's high school career, encompassing three of the following academic areas:

Area I: Languages — English Language, English Literature, French Language, French Literature, German Language, International English, Latin-Vergil, Latin Literature, Spanish Language, Spanish Literature

Area II: Science — Biology, Chemistry, Environmental Science, Physics B, Physics C–Electricity and Magnetism, Physics C–Mechanics

Area III: Mathematics — Calculus AB, Calculus BC, Statistics

Area IV: History and Social Sciences — European History, Government and Politics–Comparative, Government and Politics–U.S., Macroeconomics, Microeconomics, Psychology, U.S. History

Area V: Computer Science A, Computer Science AB, History of Art, Music Theory, Studio Art–Drawing, Studio Art–General

*See page ii for the half-year courses.

Students should take two exams in two different languages from Area I, one exam from Area II or III, and one or more exams from any other area not already used.

Graduating high school seniors who successfully meet the criteria for the AP International Diploma will be awarded the diploma prior to university matriculation, but will be responsible for communicating that fact to overseas universities. AP students below the last year of high school who register for the AP International Diploma will have this noted on any grade reports sent to overseas universities. They will receive their diploma when they meet the criteria defined above.

For further information on the Advanced Placement International Diploma, please contact: Charlotte Eielson, Associate Director, AP Program, The College Board, 45 Columbus Avenue, New York, NY 10023-6992 (Telephone 212-713-8058; e-mail: ceielson@collegeboard.org).

AP Search

High school sophomores and juniors who received grades ranging from 2 to 5 on AP Examinations taken in May of the preceding school year are identified to participating colleges and universities through descriptive questionnaires completed voluntarily by the students.

The Student and the College

The AP Program provides a curricular guide and examination in each field. Teachers who offer advanced courses and students who take the examinations must realize that all colleges do not follow the same, or even similar, procedures when they receive AP Examination grades. Many colleges grant credit and placement automatically for qualifying work on the examinations; some grant either placement or credit only. Others, which are still establishing their policies, have different policies for each AP course or make judgments on the basis of multiple criteria. Schools that offer advanced courses or plan to establish them may therefore wish to

communicate directly with the colleges that their students generally attend. (At the back of this booklet is a list of colleges reporting the use of AP Examination results.)

Further information about the AP Program can be obtained from any regional office of the College Board (see following) or from The College Board, 45 Columbus Avenue, New York, NY 10023-6992 (212-713-8000).

The College Board is a national nonprofit association that champions educational excellence for all students through the ongoing collaboration of nearly 3,000 member schools, colleges, universities, education systems, and organizations. The Board promotes—by means of responsive forums, research, programs, and policy development—universal access to high standards of learning, equity of opportunity, and sufficient financial support so that every qualified student is prepared for success in college and in work.

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AP Calendar of Testing Activities

The AP Examinations are administered to students by their high schools each May. Below is a list of the major activities that occur in conjunction with the exam administration.

SEPTEMBER: Participation Forms sent with survey and request for AP teachers' names.

OCTOBER/NOVEMBER: Secondary schools indicate their intention to participate and name their AP Coordinator. AP Coordinators return Participation Forms to ETS. ETS mails a supply of the *AP Bulletin for Students and Parents* and other information to schools.

THROUGHOUT THE YEAR: Additional mailings may occur in specific subject areas if there are significant changes in exam format or curricula.

MARCH 1–APRIL 1: AP Coordinators return Examination and Special Services Order Forms and Fee Reduction Request Forms to ETS.

APRIL: AP Coordinators receive, and should check, exam materials.

APRIL–MAY: AP schools are sent new Course Descriptions based on current year's exam order.

MAY 5–9 and 12–16, 1997: AP Examinations are administered.

JUNE: Free-response sections, tapes, and Studio Art portfolios are scored by over 3,700 high school and college faculty consultants on college campuses.

JUNE 15: Deadline to receive student letters to cancel grades, change colleges designated to receive grades, or withhold grades.

JULY: AP grades are sent to students' designated colleges and high schools and to their home addresses.

JULY–OCTOBER: Free-response booklets are available to student-designated colleges.

LATE AUGUST: *Report to AP Teachers* is sent to high schools for subjects where five or more students took the exam.

SEPTEMBER: Scholar Award notifications are sent to students and schools.

NOVEMBER: State and National Summary Reports and the *AP Yearbook* are sent to school principals and college administrators.

NOVEMBER–DECEMBER: Remaining free-response booklets are available to schools.

Note: Free-response booklets are not available for students who tested late using an alternate form of the exam.

Guidelines for Using College Board Test Scores

The following statement is taken from *Guidelines on the Uses of College Board Test Scores and Related Data* (1988).

When College Board tests are used for placement and credit purposes, the responsible officials should:

1. Determine the appropriateness of particular tests through consultation with faculty members who are familiar with the content of the tests.

2. Establish standards that are appropriate for the performance levels and ranges of their enrolled students.

3. Accept the transfer of credits earned by examination at a previous institution when scores and test content meet their own standards.

4. Publicize their placement and credit policies, making clear which tests are used, how students gain access to them, what scores are required, how much credit can be awarded for each examination, whether the credits granted meet degree requirements, and how much total credit may be obtained.

5. Identify as such the credits granted by examination on students' records and transcripts.

6. Establish fees, if any, for credits awarded by examinations based on actual costs involved rather than costs involved in instruction or other unrelated factors.

Questions about the use of College Board test scores and related data should be directed in writing to the chair of the Executive Council of the appropriate Regional Assembly of the College Board. A complete description of the particular use in question should be given. The matter will be followed up and the findings will be reported.

The Importance of Test Security

The entire AP Examination is considered to be secure until the scheduled administration date. Following that date, the free-response section (Section II) is available for teacher and student review (see the listing at the back of this booklet for details). **However, the multiple-choice section (Section I) MUST remain secure both before and after the exam administration.** No one other than the candidates taking the examination should ever have access to or see the questions contained in this section.

While some multiple-choice questions are published periodically, it is extremely important that the security of these questions remain intact. Various combinations of multiple-choice questions are reused from year to year to provide an essential method of establishing high examination reliability, controlled levels of difficulty, and comparability with earlier examinations. These goals can only be attained when the multiple-choice questions remain secure. Therefore, teachers may not view the questions and students may not share information about these questions with anyone following the exam administration.

AP Statistics

The Advanced Placement Program offers a course description and examination in statistics to students who wish to complete studies in secondary school equivalent to a one-semester, introductory, non-calculus based, college course in statistics.

The course description and examination have been prepared by statistics and mathematics educators who serve as members of the Advanced Placement Statistics Development Committee to reflect the content of a typical introductory college course in statistics. The examination is representative of such a course and therefore is considered appropriate for the measurement of skills and knowledge in the field of introductory statistics.

In colleges and universities, the number of students who take a statistics course is almost as large as the number of students who take a calculus course. At least one statistics course is typically required for majors such as engineering, psychology, sociology, health science, and business. Every semester more than 170,000 students take their first statistics course from the mathematics or statistics department at their college or university. The vast majority of these students take a non-calculus based introductory course that is equivalent to the AP Statistics course. A large number of other students take a similar introductory course from other departments who teach their own statistics course. Science, engineering, business, and mathematics majors usually take an upper division calculus-based course in statistics, for which the AP Statistics course will be effective preparation.

The Course

The purpose of the Advanced Placement course in statistics is to introduce students to the major concepts and tools for collecting, analyzing, and drawing conclusions from data. Students are exposed to four broad conceptual themes:

1. Exploring Data: Observing patterns and departures from patterns,

2. Planning a Study: Deciding what and how to measure,
3. Anticipating Patterns: Producing models using probability and simulation,
4. Statistical Inference: Confirming models.

Students who successfully complete the course and examination may receive credit and/or advanced placement for a one-semester introductory college statistics course. This does not necessarily imply that the high school course should be one semester long. Each high school will need to determine the length of time for its AP Statistics course in order to best serve the needs of its students. Statistics, like some other AP courses, could be effectively studied in a one-semester, a two-trimester, or a one-year course.

Who Should Take AP Statistics

The AP Statistics course is an excellent option for any student who has successfully completed a second-year course in algebra, regardless of the student's intended college major. Much of the content of an introductory statistics course does not require any symbol manipulation beyond the level of first-year algebra; however, most students who have studied only first-year algebra do not possess sufficient mathematical maturity and quantitative reasoning ability to complete an introductory statistics course successfully.

Since second-year algebra is the prerequisite course, AP Statistics will usually be taken in either the junior or senior year. Mathematically able students are encouraged to take AP Statistics, AP Calculus, and AP Computer Science in high school. For example, many students could take AP Statistics in their junior year and AP Calculus in their senior year, while others could take both AP Statistics and AP Calculus or AP Statistics and AP Computer Science concurrently in their senior year.

Other options for students include taking AP Statistics as their senior-year course in mathematics, either after completing Algebra II or Precalculus or concurrently with Precalculus. Indeed, students planning to take an AP science course in their senior year will benefit greatly from AP Statistics in their junior year.

Students who wish to leave open the option of taking Calculus in college should include Precalculus in their high school program.

Admission to an Advanced Placement course ordinarily depends on the student's interest in the subject as well as on a superior academic record. However, many highly motivated students with less outstanding records have successfully completed AP courses and have obtained college credit and/or advanced placement through the Advanced Placement Examinations.

AP Statistics Course Description

Course Content

The topics for AP Statistics are divided into four major themes: exploratory analysis, planning a study, probability, and statistical inference.

I. *Exploratory analysis of data makes use of graphical and numerical techniques to study patterns and departures from patterns.* In examining distributions of data, students should be able to detect important characteristics, such as shape, location, variability, and unusual values. From careful observations of patterns in data, students can generate conjectures about relationships among variables. The notion of how one variable may be associated with another permeates almost all of statistics, from simple comparisons of proportions through linear regression. The difference between association and causation must accompany this conceptual development throughout.

II. *Data must be collected according to a well-developed plan if valid information on a conjecture is to be obtained.* The plan must identify important variables related to the conjecture and specify how they are to be measured. From the data collection plan, a model can be formulated from which inferences can be drawn.

III. *Probability is the tool used for anticipating what the distribution of data should look like under a given model.* Random phenomena are not haphazard: they display an order that emerges only in the long run and is described by

a distribution. The mathematical description of variation is central to statistics. The probability required for statistical inference is not primarily axiomatic or combinatorial, but is oriented toward describing data distributions.

IV. *Statistical inference guides the selection of appropriate models.* Models and data interact in statistical work: models are used to draw conclusions from data, while the data are allowed to criticize and even falsify the model through inferential and diagnostic methods. Inference from data can be thought of as the process of selecting a reasonable model, including a statement in probability language of how confident one can be about the selection.

Outline of Topics

Following is an outline of the major topics covered by the AP Examination in Statistics. The ordering here is intended to define the scope of the course but not necessarily the sequence.

I. Exploring Data: Observing patterns and departures from patterns

Exploratory analysis of data makes use of graphical and numerical techniques to study patterns and departures from patterns. Emphasis should be placed on interpreting information from graphical and numerical displays and summaries.

A. Interpreting graphical displays of distributions of univariate data (dotplot, stemplot, histogram)
   1. Center and spread
   2. Clusters and gaps
   3. Outliers and other unusual features
   4. Shape

B. Summarizing distributions of univariate data
   1. Measuring center: median, mean
   2. Measuring spread: range, interquartile range, standard deviation
   3. Measuring position: quartiles, percentiles, standardized scores (z-scores)
   4. Using boxplots
   5. The effect of changing units on summary measures

C. Comparing distributions of univariate data (dotplots, back-to-back stemplots, parallel boxplots)
   1. Comparing center and spread: within group, between group variation
   2. Comparing clusters and gaps
   3. Comparing outliers and other unusual features
   4. Comparing shapes

D. Exploring bivariate data
   1. Analyzing patterns in scatterplots
   2. Correlation and linearity
   3. Least squares regression line
   4. Residual plots, outliers, and influential points
   5. Transformations to achieve linearity: logarithmic and power transformations

E. Exploring categorical data: frequency tables
   1. Marginal and joint frequencies for two-way tables
   2. Conditional relative frequencies and association

II. Planning a Study: Deciding what and how to measure

Data must be collected according to a well-developed plan if valid information on a conjecture is to be obtained. This plan includes clarifying the question and deciding upon a method of data collection and analysis.

A. Overview of methods of data collection
   1. Census
   2. Sample survey
   3. Experiment
   4. Observational study

B. Planning and conducting surveys
   1. Simple random sampling
   2. Characteristics of a well-designed and conducted survey
   3. Sampling error: the variation inherent in a survey
   4. Sources of bias in surveys
   5. Stratifying to reduce variation

C. Planning and conducting experiments
   1. Experiments versus observational studies versus surveys
   2. Confounding, control groups, placebo effects, blinding
   3. Treatments, experimental units, and randomization
   4. Completely randomized design for two treatments
   5. Randomized paired comparison design
   6. Replication, blocking, and generalizability of results

III. Anticipating Patterns: Producing models using probability and simulation

Probability is the tool used for anticipating what the distribution of data should look like under a given model.

A. Probability as relative frequency
   1. "Law of large numbers" concept
   2. Addition rule, multiplication rule, conditional probabilities, and independence
   3. Discrete random variables and their probability distributions
   4. Simulation of probability distributions, including binomial and geometric
   5. Mean (expected value) and standard deviation of a random variable, including binomial

B. Combining independent random variables
   1. Notion of independence versus dependence
   2. Mean and standard deviation for sums and differences of independent random variables

C. The normal distribution
   1. Properties of the normal distribution
   2. Using tables of the normal distribution
   3. The normal distribution as a model for measurements

D. Simulating sampling distribution
   1. Sampling distribution of a sample proportion
   2. Sampling distribution of a sample mean
   3. Central Limit Theorem
   4. Sampling distribution of a difference between two independent sample proportions
   5. Sampling distribution of a difference between two independent sample means

IV. Statistical Inference: Confirming models

Statistical inference guides the selection of appropriate models.

A. Confidence intervals
   1. The meaning of a confidence interval
   2. Large sample confidence interval for a proportion
   3. Large sample confidence interval for a mean
   4. Large sample confidence interval for a difference between two proportions
   5. Large sample confidence interval for a difference between two means (unpaired and paired)

B. Tests of significance
   1. Logic of significance testing, null and alternative hypotheses; p-values; one- and two-sided tests
   2. Large sample test for a proportion
   3. Large sample test for a mean
   4. Large sample test for a difference between two proportions
   5. Large sample test for a difference between two means (unpaired and paired)
   6. Chi-square test for goodness of fit, homogeneity of proportions, and independence

C. Special case of normally distributed data
   1. t-distribution
   2. Single sample t procedures
   3. Two sample (independent and matched pairs) t procedures
   4. Inference for slope of least squares line

The Use of Technology in AP Statistics

The AP Statistics course adheres to the philosophy and methods of modern data analysis. Although the distinction between graphing calculators and computers is becoming blurred as technology advances, at present, the fundamental tool of data analysis is the computer. The computer does more than eliminate the drudgery of hand computation and graphing. It is an essential tool for structured inquiry.

Data analysis is a journey of discovery. It is fundamentally an iterative process that involves a dialogue between the data and a mathematical model. As more is learned about the data, the model is refined and new questions are formed. The computer aids in this journey in some fundamental ways. First, it produces graphs that are specifically designed for data analysis. These graphical displays make it easier to observe patterns in data, to identify important subgroups of the data, and to locate any unusual data points. Second, the computer allows the student to fit complex mathematical models to the data and to assess how well the model fits the data by examining the residuals. The result of this examination is often the need to re-express the data, for example by taking the logarithm of a variable, and repeating the analysis after re-expression. Finally, the computer is helpful in identifying an observation that has an undue influence on the analysis and isolating its effects.

In addition to its use in data analysis, the computer facilitates the simulation approach to probability that is emphasized in the AP Statistics course. Probabilities of random events, probability distributions of random variables, and sampling distributions of statistics can be studied from a general, conceptual approach through simulation. This frees the student and teacher from the narrow approach that depends on a few simple probabilistic models.

Because the computer is central to what statisticians do, it is considered essential for teaching the AP Statistics course. It is not yet possible for students to have access to a computer during the AP Statistics exam. Without a computer and under the conditions of a timed exam, students cannot be asked to perform the amount of computation that is needed for many statistical investi-

gations. Consequently, standard computer output will be provided as necessary and students will be expected to interpret it. (See, for example, free-response question #4 on page 33.)

Each student will be expected to bring a graphing calculator with statistics capabilities to the examination and to be familiar with its use. The calculator's computational capabilities should include descriptive statistics such as the standard deviation, the correlation coefficient, and the equation of the least squares linear regression line. Graphical capabilities should include the ability to make a scatterplot and to graph the least squares linear regression line. Students find calculators where data is entered into a spread-sheet format particularly easy to use. A graphing calculator is a useful computational aid, particularly in analyzing small data sets, but should not be considered equivalent to a computer in the teaching of statistics. Ideally, students in an AP Statistics course should have access to both for work in and outside the classroom. (See the insert for a list of suggested software packages.)

Instructional Emphasis in AP Statistics

The AP Statistics course lends itself naturally to a mode of teaching that engages students in constructing their own knowledge. For example, students working individually or in small groups can plan and perform data collection and analyses where the teacher serves in the role of a consultant, rather than a director. This approach gives students ample opportunity to think through problems, make decisions, and share questions and conclusions with other students as well as with the teacher.

Important components of the course should include the use of technology, projects and laboratories, cooperative group problem-solving, and writing as a part of concept-oriented instruction and assessment. This approach to teaching AP Statistics will allow students to build interdisciplinary connections with other subjects and with their world outside school.

The AP Statistics course depends heavily on the availability of technology suitable for the interactive, investigative aspects of data analysis. Therefore, schools should make every effort to provide students and teachers easy access to computers to facilitate

the teaching and learning of statistics.

Providing instructional information and training opportunities for teachers is an important component of the Advanced Placement Program. The College Board will offer workshops and summer courses and institutes for beginning teachers in Advanced Placement Statistics. Further information about these and other training opportunities may be obtained from the College Board Regional Office in your area (see p. viii).

Additionally, the following publications provide some insight into the philosophy of the AP Statistics course.

Curriculum and Evaluation Standards for School Mathematics, The National Council of Teachers of Mathematics, Reston, Virginia, 1989.

Statistics for the Twenty-First Century, Florence and Sheldon Gordon, The Mathematical Association of America, Washington, D.C., 1992 (1-800-331-1622).

Teaching Statistics: More Data, Less Lecturing, a paper by George Cobb in *Heeding the Call for Change: Suggestions for Curricular Action*, Lynn Arthur Steen, Ed., The Mathematical Association of America, Washington, D.C., 1992 (pp. 3–43).

Formulas and Tables

Students enrolled in the AP Statistics course should concentrate their time and effort on developing a thorough understanding of the fundamental concepts of statistics. They should not be required to memorize formulas.

The following list of formulas and tables will be furnished to students taking the AP Statistics Examination. Teachers are encouraged to familiarize their students with the form and notation of

these formulas by making them accessible to their students at the appropriate time during the course.

(I) Descriptive Statistics

$$\bar{x} = \frac{\sum x_i}{n}$$

$$s_x = \sqrt{\frac{1}{n-1}\sum (x_i - \bar{x})^2}$$

$$s_p = \sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{(n_1 - 1) + (n_2 - 1)}}$$

$$\hat{y} = b_0 + b_1 x$$

$$b_1 = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sum (x_i - \bar{x})^2}$$

$$b_0 = \bar{y} - b_1 \bar{x}$$

$$r = \frac{1}{n-1}\sum \left(\frac{x_i - \bar{x}}{s_x}\right)\left(\frac{y_i - \bar{y}}{s_y}\right)$$

$$b_1 = r\,\frac{s_y}{s_x}$$

$$s_{b_1} = \frac{\sqrt{\frac{\sum (y_i - \hat{y}_i)^2}{n-2}}}{\sqrt{\sum (x_i - \bar{x})^2}}$$

(II) Probability

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

$$P(A|B) = \frac{P(A \cap B)}{P(B)}$$

$$E(X) = \mu_x = \sum x_i p_i$$

$$Var(X) = \sigma_x^2 = \sum (x_i - \mu_x)^2 p_i$$

If X has a binomial distribution with parameters n and p, then:

$$P(X = k) = \binom{n}{k} p^k (1 - p)^{n-k}$$

$$\mu_x = np$$

$$\sigma_x = \sqrt{np(1 - p)}$$

$$\mu_{\hat{p}} = p$$

$$\sigma_{\hat{p}} = \sqrt{\frac{p(1 - p)}{n}}$$

If X has a normal distribution with mean μ and standard deviation σ, then:

$$\mu_x = \mu$$

$$\sigma_x = \frac{\sigma}{\sqrt{n}}$$

(III) Inferential Statistics

standardized test statistic: $\dfrac{\text{estimate} - \text{parameter}}{\text{standard deviation of the estimate}}$

confidence interval: estimate ± (critical value) • (standard deviation of the estimate)

Single Sample

statistic	standard deviation
mean	$\frac{\sigma}{\sqrt{n}}$
proportion	$\sqrt{\frac{p(1-p)}{n}}$

Two Sample

statistic	standard deviation
difference of means (unequal variances)	$\sqrt{\frac{\sigma_1^2}{n_1}+\frac{\sigma_2^2}{n_2}}$
difference of means (equal variances)	$\sigma\sqrt{\frac{1}{n_1}+\frac{1}{n_2}}$
difference of proportions (unequal variances)	$\sqrt{\frac{p_1(1-p_1)}{n_1}+\frac{p_2(1-p_2)}{n_2}}$
difference of proportions (equal variances)	$\sqrt{p(1-p)}\ \sqrt{\frac{1}{n_1}+\frac{1}{n_2}}$

$$\text{Chi-square test statistic} = \sum \frac{(\text{observed} - \text{expected})^2}{\text{expected}}$$

Table entry for z is the probability lying below z.

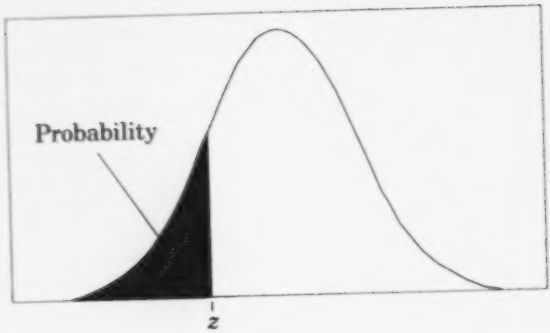

Table A Standard normal probabilities

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
-3.4	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0002
-3.3	.0005	.0005	.0005	.0004	.0004	.0004	.0004	.0004	.0004	.0003
-3.2	.0007	.0007	.0006	.0006	.0006	.0006	.0006	.0005	.0005	.0005
-3.1	.0010	.0009	.0009	.0009	.0008	.0008	.0008	.0008	.0007	.0007
-3.0	.0013	.0013	.0013	.0012	.0012	.0011	.0011	.0011	.0010	.0010
-2.9	.0019	.0018	.0018	.0017	.0016	.0016	.0015	.0015	.0014	.0014
-2.8	.0026	.0025	.0024	.0023	.0023	.0022	.0021	.0021	.0020	.0019
-2.7	.0035	.0034	.0033	.0032	.0031	.0030	.0029	.0028	.0027	.0026
-2.6	.0047	.0045	.0044	.0043	.0041	.0040	.0039	.0038	.0037	.0036
-2.5	.0062	.0060	.0059	.0057	.0055	.0054	.0052	.0051	.0049	.0048
-2.4	.0082	.0080	.0078	.0075	.0073	.0071	.0069	.0068	.0066	.0064
-2.3	.0107	.0104	.0102	.0099	.0096	.0094	.0091	.0089	.0087	.0084
-2.2	.0139	.0136	.0132	.0129	.0125	.0122	.0119	.0116	.0113	.0110
-2.1	.0179	.0174	.0170	.0166	.0162	.0158	.0154	.0150	.0146	.0143
-2.0	.0228	.0222	.0217	.0212	.0207	.0202	.0197	.0192	.0188	.0183
-1.9	.0287	.0281	.0274	.0268	.0262	.0256	.0250	.0244	.0239	.0233
-1.8	.0359	.0351	.0344	.0336	.0329	.0322	.0314	.0307	.0301	.0294
-1.7	.0446	.0436	.0427	.0418	.0409	.0401	.0392	.0384	.0375	.0367
-1.6	.0548	.0537	.0526	.0516	.0505	.0495	.0485	.0475	.0465	.0455
-1.5	.0668	.0655	.0643	.0630	.0618	.0606	.0594	.0582	.0571	.0559
-1.4	.0808	.0793	.0778	.0764	.0749	.0735	.0721	.0708	.0694	.0681
-1.3	.0968	.0951	.0934	.0918	.0901	.0885	.0869	.0853	.0838	.0823
-1.2	.1151	.1131	.1112	.1093	.1075	.1056	.1038	.1020	.1003	.0985
-1.1	.1357	.1335	.1314	.1292	.1271	.1251	.1230	.1210	.1190	.1170
-1.0	.1587	.1562	.1539	.1515	.1492	.1469	.1446	.1423	.1401	.1379
-0.9	.1841	.1814	.1788	.1762	.1736	.1711	.1685	.1660	.1635	.1611
-0.8	.2119	.2090	.2061	.2033	.2005	.1977	.1949	.1922	.1894	.1867
-0.7	.2420	.2389	.2358	.2327	.2296	.2266	.2236	.2206	.2177	.2148
-0.6	.2743	.2709	.2676	.2643	.2611	.2578	.2546	.2514	.2483	.2451
-0.5	.3085	.3050	.3015	.2981	.2946	.2912	.2877	.2843	.2810	.2776
-0.4	.3446	.3409	.3372	.3336	.3300	.3264	.3228	.3192	.3156	.3121
-0.3	.3821	.3783	.3745	.3707	.3669	.3632	.3594	.3557	.3520	.3483
-0.2	.4207	.4168	.4129	.4090	.4052	.4013	.3974	.3936	.3897	.3859
-0.1	.4602	.4562	.4522	.4483	.4443	.4404	.4364	.4325	.4286	.4247
-0.0	.5000	.4960	.4920	.4880	.4840	.4801	.4761	.4721	.4681	.4641

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Table entry for z is the probability lying below z.

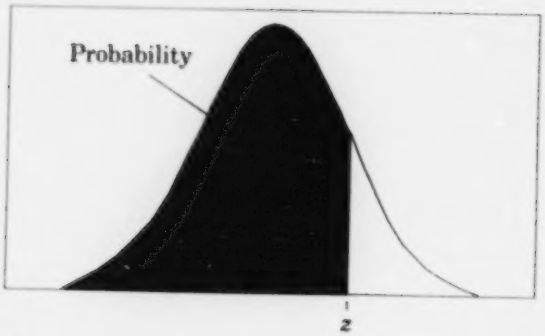

Table A *(Continued)*

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
0.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
0.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
0.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
0.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
0.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
0.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
0.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
0.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
0.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986
3.0	.9987	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990
3.1	.9990	.9991	.9991	.9991	.9992	.9992	.9992	.9992	.9993	.9993
3.2	.9993	.9993	.9994	.9994	.9994	.9994	.9994	.9995	.9995	.9995
3.3	.9995	.9995	.9995	.9996	.9996	.9996	.9996	.9996	.9996	.9997
3.4	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9998

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Table entry for p and C is the point t^* with probability p lying above it and probability C lying between $-t^*$ and t^*.

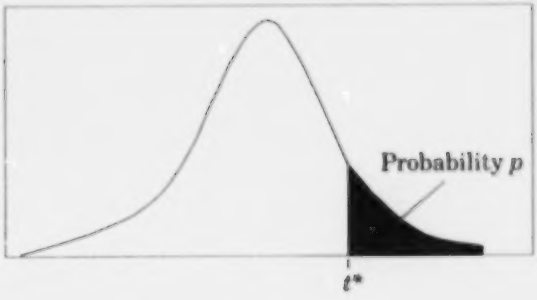

Table B

t distribution critical values

	Tail probability p											
df	.25	.20	.15	.10	.05	.025	.02	.01	.005	.0025	.001	.0005
1	1.000	1.376	1.963	3.078	6.314	12.71	15.89	31.82	63.66	127.3	318.3	636.6
2	.816	1.061	1.386	1.886	2.920	4.303	4.849	6.965	9.925	14.09	22.33	31.60
3	.765	.978	1.250	1.638	2.353	3.182	3.482	4.541	5.841	7.453	10.21	12.92
4	.741	.941	1.190	1.533	2.132	2.776	2.999	3.747	4.604	5.598	7.173	8.610
5	.727	.920	1.156	1.476	2.015	2.571	2.757	3.365	4.032	4.773	5.893	6.869
6	.718	.906	1.134	1.440	1.943	2.447	2.612	3.143	3.707	4.317	5.208	5.959
7	.711	.896	1.119	1.415	1.895	2.365	2.517	2.998	3.499	4.029	4.785	5.408
8	.706	.889	1.108	1.397	1.860	2.306	2.449	2.896	3.355	3.833	4.501	5.041
9	.703	.883	1.100	1.383	1.833	2.262	2.398	2.821	3.250	3.690	4.297	4.781
10	.700	.879	1.093	1.372	1.812	2.228	2.359	2.764	3.169	3.581	4.144	4.587
11	.697	.876	1.088	1.363	1.796	2.201	2.328	2.718	3.106	3.497	4.025	4.437
12	.695	.873	1.083	1.356	1.782	2.179	2.303	2.681	3.055	3.428	3.930	4.318
13	.694	.870	1.079	1.350	1.771	2.160	2.282	2.650	3.012	3.372	3.852	4.221
14	.692	.868	1.076	1.345	1.761	2.145	2.264	2.624	2.977	3.326	3.787	4.140
15	.691	.866	1.074	1.341	1.753	2.131	2.249	2.602	2.947	3.286	3.733	4.073
16	.690	.865	1.071	1.337	1.746	2.120	2.235	2.583	2.921	3.252	3.686	4.015
17	.689	.863	1.069	1.333	1.740	2.110	2.224	2.567	2.898	3.222	3.646	3.965
18	.688	.862	1.067	1.330	1.734	2.101	2.214	2.552	2.878	3.197	3.611	3.922
19	.688	.861	1.066	1.328	1.729	2.093	2.205	2.539	2.861	3.174	3.579	3.883
20	.687	.860	1.064	1.325	1.725	2.086	2.197	2.528	2.845	3.153	3.552	3.850
21	.686	.859	1.063	1.323	1.721	2.080	2.189	2.518	2.831	3.135	3.527	3.819
22	.686	.858	1.061	1.321	1.717	2.074	2.183	2.508	2.819	3.119	3.505	3.792
23	.685	.858	1.060	1.319	1.714	2.069	2.177	2.500	2.807	3.104	3.485	3.768
24	.685	.857	1.059	1.318	1.711	2.064	2.172	2.492	2.797	3.091	3.467	3.745
25	.684	.856	1.058	1.316	1.708	2.060	2.167	2.485	2.787	3.078	3.450	3.725
26	.684	.856	1.058	1.315	1.706	2.056	2.162	2.479	2.779	3.067	3.435	3.707
27	.684	.855	1.057	1.314	1.703	2.052	2.158	2.473	2.771	3.057	3.421	3.690
28	.683	.855	1.056	1.313	1.701	2.048	2.154	2.467	2.763	3.047	3.408	3.674
29	.683	.854	1.055	1.311	1.699	2.045	2.150	2.462	2.756	3.038	3.396	3.659
30	.683	.854	1.055	1.310	1.697	2.042	2.147	2.457	2.750	3.030	3.385	3.646
40	.681	.851	1.050	1.303	1.684	2.021	2.123	2.423	2.704	2.971	3.307	3.551
50	.679	.849	1.047	1.299	1.676	2.009	2.109	2.403	2.678	2.937	3.261	3.496
60	.679	.848	1.045	1.296	1.671	2.000	2.099	2.390	2.660	2.915	3.232	3.460
80	.678	.846	1.043	1.292	1.664	1.990	2.088	2.374	2.639	2.887	3.195	3.416
100	.677	.845	1.042	1.290	1.660	1.984	2.081	2.364	2.626	2.871	3.174	3.390
1000	.675	.842	1.037	1.282	1.646	1.962	2.056	2.330	2.581	2.813	3.098	3.300
∞	.674	.841	1.036	1.282	1.645	1.960	2.054	2.326	2.576	2.807	3.091	3.291
	50%	60%	70%	80%	90%	95%	96%	98%	99%	99.5%	99.8%	99.9%
	Confidence level C											

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Table entry for p is the point (X^2) with probability p lying above it.

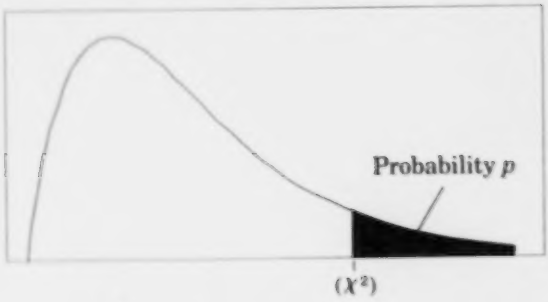

Table C

χ^2 critical values

	Tail probability p										
df	.25	.20	.15	.10	.05	.025	.02	.01	.005	.0025	.001
1	1.32	1.64	2.07	2.71	3.84	5.02	5.41	6.63	7.88	9.14	10.83
2	2.77	3.22	3.79	4.61	5.99	7.38	7.82	9.21	10.60	11.98	13.82
3	4.11	4.64	5.32	6.25	7.81	9.35	9.84	11.34	12.84	14.32	16.27
4	5.39	5.99	6.74	7.78	9.49	11.14	11.67	13.28	14.86	16.42	18.47
5	6.63	7.29	8.12	9.24	11.07	12.83	13.39	15.09	16.75	18.39	20.51
6	7.84	8.56	9.45	10.64	12.59	14.45	15.03	16.81	18.55	20.25	22.46
7	9.04	9.80	10.75	12.02	14.07	16.01	16.62	18.48	20.28	22.04	24.32
8	10.22	11.03	12.03	13.36	15.51	17.53	18.17	20.09	21.95	23.77	26.12
9	11.39	12.24	13.29	14.68	16.92	19.02	19.68	21.67	23.59	25.46	27.88
10	12.55	13.44	14.53	15.99	18.31	20.48	21.16	23.21	25.19	27.11	29.59
11	13.70	14.63	15.77	17.28	19.68	21.92	22.62	24.72	26.76	28.73	31.26
12	14.85	15.81	16.99	18.55	21.03	23.34	24.05	26.22	28.30	30.32	32.91
13	15.98	16.98	18.20	19.81	22.36	24.74	25.47	27.69	29.82	31.88	34.53
14	17.12	18.15	19.41	21.06	23.68	26.12	26.87	29.14	31.32	33.43	36.12
15	18.25	19.31	20.60	22.31	25.00	27.49	28.26	30.58	32.80	34.95	37.70
16	19.37	20.47	21.79	23.54	26.30	28.85	29.63	32.00	34.27	36.46	39.25
17	20.49	21.61	22.98	24.77	27.59	30.19	31.00	33.41	35.72	37.95	40.79
18	21.60	22.76	24.16	25.99	28.87	31.53	32.35	34.81	37.16	39.42	42.31
19	22.72	23.90	25.33	27.20	30.14	32.85	33.69	36.19	38.58	40.88	43.82
20	23.83	25.04	26.50	28.41	31.41	34.17	35.02	37.57	40.00	42.34	45.31
21	24.93	26.17	27.66	29.62	32.67	35.48	36.34	38.93	41.40	43.78	46.80
22	26.04	27.30	28.82	30.81	33.92	36.78	37.66	40.29	42.80	45.20	48.27
23	27.14	28.43	29.98	32.01	35.17	38.08	38.97	41.64	44.18	46.62	49.73
24	28.24	29.55	31.13	33.20	36.42	39.36	40.27	42.98	45.56	48.03	51.18
25	29.34	30.68	32.28	34.38	37.65	40.65	41.57	44.31	46.93	49.44	52.62
26	30.43	31.79	33.43	35.56	38.89	41.92	42.86	45.64	48.29	50.83	54.05
27	31.53	32.91	34.57	36.74	40.11	43.19	44.14	46.96	49.64	52.22	55.48
28	32.62	34.03	35.71	37.92	41.34	44.46	45.42	48.28	50.99	53.59	56.89
29	33.71	35.14	36.85	39.09	42.56	45.72	46.69	49.59	52.34	54.97	58.30
30	34.80	36.25	37.99	40.26	43.77	46.98	47.96	50.89	53.67	56.33	59.70
40	45.62	47.27	49.24	51.81	55.76	59.34	60.44	63.69	66.77	69.70	73.40
50	56.33	58.16	60.35	63.17	67.50	71.42	72.61	76.15	79.49	82.66	86.66
60	66.98	68.97	71.34	74.40	79.08	83.30	84.58	88.38	91.95	95.34	99.61
80	88.13	90.41	93.11	96.58	101.9	106.6	108.1	112.3	116.3	120.1	124.8
100	109.1	111.7	114.7	118.5	124.3	129.6	131.1	135.8	140.2	144.3	149.4

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The Examination

The AP Statistics Examination is three hours long and seeks to determine how well a student has mastered the concepts and techniques of the subject matter of the course. This paper-and-pencil examination consists of (1) a multiple-choice section testing proficiency in a wide variety of topics, and (2) a free-response section requiring the student to answer open-ended questions and to complete an investigative task involving more extended reasoning. Each student will be expected to bring a graphing calculator with statistical capabilities to the examination. Minicomputers, pocket organizers, electronic writing pads (Newton), and calculators with QWERTY (i.e., typewriter) keyboards will not be allowed. Calculator memories will not be cleared. A student may bring up to two calculators to the examination. In the determination of the grade for the examination, the two sections will be given equal weight.

Multiple-Choice Questions

The following are examples of the kinds of multiple-choice questions found on the AP Statistics Examination. The distribution of topics and the levels of difficulty are illustrative of the composition of the examination. Students often ask whether they should guess on the multiple-choice section. Haphazard or random guessing is unlikely to improve scores, because one-fourth of the number of questions answered incorrectly will be subtracted from the number of questions answered correctly. However, students who have some knowledge of a question and can eliminate one or more answer choices will usually find it advantageous to guess from among the remaining choices. An answer key to the multiple-choice questions can be found on page 41.

Directions: Each of the questions or incomplete statements is followed by five suggested answers or completions. Select the one that best answers the question or completes the statement.

1. A sample of 56 college students was asked to report the number of hours devoted to study during a typical week. The stem-and-leaf plot of the results is shown below.

STEM-AND-LEAF OF STUDY HOURS (n = 56)

0	3
0	5555667777778999
1	00000000001122223333444444
1	5555668
2	0
2	56
3	00
3	5
4	0

1 | 5 represents 15 study hours

Which of the following best describes these data?

(A) Skewed distribution; mean greater than median.
(B) Skewed distribution; mean less than median.
(C) Symmetric distribution; mean greater than median.
(D) Symmetric distribution; mean less than median.
(E) Symmetric distribution with outliers on high end.

Note to teachers: A student is expected to be able to recognize whether the mean is greater than or less than the median without doing any calculations.

2. A random sample of size 10 was taken from a population. The sample has a variance of zero. Which of the following statements must be true?

I. The population also has a variance of zero.
II. The sample mean is equal to the sample median.
III. The ten data points in the sample are equal in numerical value.

(A) I only
(B) II only
(C) III only
(D) I and II
(E) II and III

3. A professor teaches two statistics classes. The morning class has 25 students and their average on the first test was 82. The evening class has 15 students and their average on the same test was 74. What is the average on this test if the professor combines the scores for both classes?

(A) 76
(B) 78
(C) 79
(D) 80
(E) The average cannot be calculated since individual scores of each student are not available.

4. The least squares regression line for a given set of data, $\hat{y} = b_0 + \frac{1}{2}x$, passes through the point (2, 2). If $\bar{x}$ is the sample mean of x-values and $\bar{y}$ is the sample mean of y-values, then $\bar{y} =$

(A) $\frac{1}{2}\bar{x}$
(B) $\frac{1}{2}x + 1$
(C) $\bar{x}$
(D) $\bar{x} - 1$
(E) $\bar{x} + 2$

5.

x	$P(X = x)$
1	$\frac{1}{6}$
2	$\frac{2}{3}$
3	?

y	$P(Y = y)$
1	?
2	$\frac{1}{4}$
3	$\frac{1}{4}$
4	?

The tables above show part of the probability distribution for random variables X and Y. If X and Y are independent and the joint probability $P(X = 3,\ Y = 4) = \frac{1}{16}$, then $P(Y = 1) =$

(A) $\frac{1}{8}$

(B) $\frac{1}{6}$

(C) $\frac{1}{4}$

(D) $\frac{3}{8}$

(E) $\frac{1}{2}$

6. In 1993 the nationwide mean SAT verbal score was 424 with a standard deviation of about 100 and the mean SAT math score was 478 with a standard deviation of about 100. If the two scores are added for each student, the mean of the combined scores is 902. What is the standard deviation of the combined verbal and math scores?

(A) $\frac{100}{\sqrt{2}}$ (approximately 70.71)

(B) 100

(C) $\sqrt{100^2 + 100^2}$ (approximately 141.42)

(D) 200

(E) The standard deviation cannot be computed from the information given.

7. A random sample of two observations is taken from a population that is normally distributed with a mean of 100 and a standard deviation of 5. What is the probability that the sum of the two observations is greater than 221?

(A) .0015
(B) .0250
(C) .0500
(D) .4500
(E) .9985

8. A particular psychological test is used to measure academic motivation. The average test score for all female college students nationwide is 115. A large university estimates the mean test score for female students on its campus by testing a random sample of n female students and constructing a confidence interval based on their scores.

Which of the following statements about the confidence interval are true?

I. The resulting interval will contain 115.
II. The 95 percent confidence interval for $n = 100$ will generally be shorter than the 95 percent confidence interval for $n = 50$.
III. For $n = 100$, the 95 percent confidence interval will be longer than the 90 percent confidence interval.

(A) I only
(B) II only
(C) III only
(D) II and III
(E) None of the above gives the complete set of true responses.

9. A survey was conducted at a movie theater to determine movie-goers' preference for different kinds of popcorn. The results of the survey showed that Brand A was preferred by 65 percent of the people with a margin of error of plus or minus 3 percent. What is meant by the statement "plus or minus 3 percent"?

(A) Three percent of the population that was surveyed will change their minds.
(B) Three percent of the time the results of such a survey are not accurate.
(C) Three percent of the population was surveyed.
(D) The true proportion of the population who preferred Brand A popcorn could be determined if 3 percent more of the population was surveyed.
(E) It would be unlikely to get the observed sample proportion of 65 percent unless the actual percentage of people in the population of movie-goers who prefer Brand A is between 62 percent and 68 percent.

10. When performing a test of significance for a null hypothesis, H_0, against an alternative hypothesis, H_a, the p-value is

(A) the probability that H_0 is true.
(B) the probability that H_a is true.
(C) the probability that H_0 is false.
(D) the probability of observing a value of a test statistic at least as extreme as that observed in the sample if H_0 is true.
(E) the probability of observing a value of a test statistic at least as extreme as that observed in the sample if H_a is true.

11. Twenty men and 20 women with high blood pressure were subjects in an experiment to determine the effectiveness of a new drug in lowering blood pressure. Ten of the 20 men and 10 of the 20 women were chosen at random to receive the new drug. The remaining 10 men and 10 women received a placebo. The change in blood pressure was measured for each subject. The design of this experiment is

(A) completely randomized with one factor, drug
(B) completely randomized with one factor, gender
(C) randomized block, blocked by drug and gender
(D) randomized block, blocked by drug
(E) randomized block, blocked by gender

12. A large elementary school has 15 classrooms, with 24 children in each classroom. A sample of 30 children is chosen by the following procedure.

Each of the 15 teachers selects 2 children from his or her classroom to be in the sample by numbering the children from 1 to 24, then using a random digit table to select two different random numbers between 01 and 24. The 2 children with those numbers are in the sample.

Did this procedure give a simple random sample of 30 children from the elementary school?

(A) No, because the teachers were not selected randomly.
(B) No, because not all possible groups of 30 children had the same chance of being chosen.
(C) No, because not all children had the same chance of being chosen.
(D) Yes, because each child had the same chance of being chosen.
(E) Yes, because the numbers were assigned randomly to the children.

13. The primary reason for using blocking when designing an experiment is to reduce

(A) the sensitivity of the experiment
(B) variation
(C) the need for randomization
(D) bias
(E) confounding

(See p. 41 for Answer Key to Multiple-Choice Questions.)

Free-Response Questions

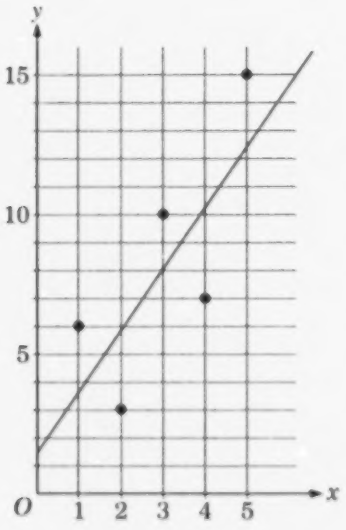
In the free-response section of the AP Statistics Examination, students are asked to answer open-ended questions and to complete an investigative task. Each open-ended question is designed to be answered in approximately 10 minutes and each examination will contain four to seven of these questions. The longer investigative task is designed to be answered in approximately 30 minutes and each examination will contain one of these tasks. The questions require students to relate different content areas as they formulate a complete solution to a statistics or probability problem. Students are expected to use their analytical and organizational skills to formulate cogent answers in writing their responses. Students will, as always, be expected to show enough of their work for readers to follow their line of reasoning. (It is not necessary to write out routine statistical calculations that can be done on a calculator.)

Solutions to free-response questions will be graded on how well the student analyzes the situation and on how clearly and completely the student communicates his or her reasoning in each step of that analysis. In the response, the student should identify the important components of the problem, synthesize logical and correct relationships among those components using appropriate statistical principles and techniques (including plots when warranted), and state the conclusions drawn, with necessary caveats. Although correct arithmetic is of secondary importance to clear communication of knowledge of statistical principles, a student should recognize when a numerical answer is unreasonable.

The following are four sample open-ended questions and two sample investigative tasks.

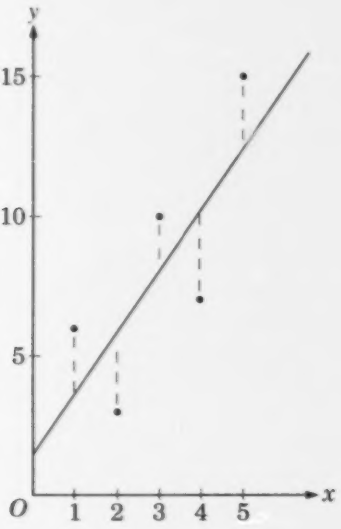
Directions: Show all your work. Indicate clearly the methods you use because you will be graded on the correctness of your methods as well as the accuracy of your final answers.

Four Open-Ended Questions



1. The regression line $\hat{y} = 1.6 + 2.2x$ for the five points on the scatterplot above was computed using the method of least squares. Use the above scatterplot to demonstrate the meaning of the term "least squares."

One Possible Solution to Question Number 1



The least squares regression line is used as a model that predicts the value of y when x is given. Since we think of x as being fixed, we measure the error in the prediction of y as the vertical distance from the point to the regression line. These errors (residuals) are the lengths of the dotted lines on the scatterplot above.

The method of least squares finds the line that makes the sum of the squares of these errors as small as possible.

For the given points, the sum of the squared errors from the line $\hat{y} = 1.6 + 2.2x$ is

$[6 - (2.2(1) + 1.6)]^2 + [3 - (2.2(2) + 1.6)]^2 + [10 - (2.2(3) + 1.6)]^2 + [7 - (2.2(4) + 1.6)]^2 + [15 - (2.2(5) + 1.6)]^2 = 34.4$

No other line gives a smaller sum than 34.4.

(Note: An acceptable response for this question need not show any calculations if the explanation is adequate.)

2. Since most people are right-handed, a company that designs machinery has traditionally placed the controls that demand the most hand strength so that they will be used by the right hand. The company decides that it should test its assumption that the right hand of right-handed adults tends to be stronger than the left hand. Nine right-handed adults are selected from employees of this company for the test. Hand strength is measured by using a calibrated hand gripper. It is reasonable to assume that the difference in people's left hand and right hand strength is approximately normally distributed. The people test their left hand first and then their right hand. The hand strengths, in kilograms, for each person and summary statistics are given below.

Person	1	2	3	4	5	6	7	8	9
Right Hand	11.7	12.7	11.4	12.4	12.2	11.3	11.1	11.7	11.7
Left Hand	11.6	11.2	10.6	11.2	10.9	10.9	10.7	10.3	10.5
Difference	0.1	1.5	0.8	1.2	1.3	0.4	0.4	1.4	1.2

SUMMARY STATISTICS

	Right Hand Strength	Left Hand Strength	Right Hand Strength Minus Left Hand Strength
Mean	11.8	10.9	0.9
Std. Dev.	0.5	0.4	0.5
Variance	0.281	0.164	0.261

Do these data support the conclusion that the right hand of right-handed adults tends to be stronger than the left hand? Give an appropriate statistical justification. Briefly discuss any concerns you have about the design of this study.

One Possible Solution to Question Number 2

Yes, $t = \frac{(0.9)(\sqrt{9})}{0.5} = 5.4$ with $df = 8$, which is significant at the 0.0005 level.

The matched pairs t-test is appropriate because each right hand is matched with the left hand for that adult and the subjects were randomly selected. We can assume the population of differences is normally distributed. Therefore, it is highly unlikely that this difference in hand strength is due to chance variation alone.

The design of the study may be improved by randomizing the order of which hand grips the hand gripper first or by using a more accurate measuring device.

Another Possible Solution to Question Number 2

Let the null hypothesis be $p = 0.5$, where p is the proportion of right-handed adults whose right hand strength is greater than the left hand strength.

Compute the probability that, in a population with probability $p = 0.5$ of a success, we would get 9 successes in a random sample of size 9. The probability of 9 successes under the null hypothesis is the same as the probability of flipping a coin 9 times and getting 9 heads: $(0.5)^9 = 0.00195$. We reject the null hypothesis. It is highly unlikely that all 9 people in the random sample would have the right hand strength greater than the left hand strength if those two events are equally likely in the population.

Randomize the order of which hand grips the hand gripper first. Use other tests of hand strength. Use a more accurate measuring device.

3. Cuckoos lay their eggs in the nests of other birds. Some biologists speculate that the size of the cuckoo's eggs might be different depending on whether the eggs are laid in warblers' nests or wrens' nests. To check this, biologists searched a wildlife refuge for warblers' and wrens' nests. Summary statistics for the lengths (in mm) of cuckoo's eggs found in the nests of warblers and wrens are shown below.

   Eggs from warblers' nests: $n_1 = 29, \bar{x}_1 = 22.20, s_1 = 0.65$
   Eggs from wrens' nests: $n_2 = 35, \bar{x}_2 = 21.12, s_2 = 0.75$

   Use a 99 percent confidence interval to determine if these data support the biologists' speculation that the size of the eggs differs depending on whether they are laid in warblers' nests or wrens' nests.

One Possible Solution to Question Number 3

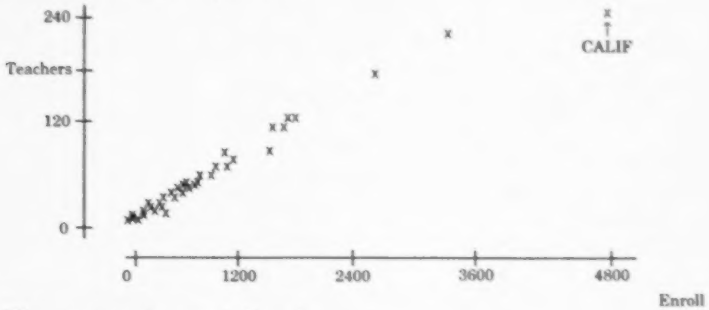
The data support the biologists' speculation because zero is not in the confidence interval. If the difference between the mean lengths of the eggs in the entire population of eggs was actually zero, then there is less than one chance in a hundred that the 99 percent confidence interval would not contain zero. Therefore we conclude that the difference probably is not zero.

$$(\bar{x}_1 - \bar{x}_2) \pm t\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}} = (22.20 - 21.12) \pm 2.763\sqrt{\frac{0.65^2}{29} + \frac{0.75^2}{35}}$$

$$= 1.08 \pm .0484$$

$$= (0.596, 1.564)$$

4. The following scatterplot shows the number of teachers (in thousands) for each of the states plus the District of Columbia plotted against the number of students (in thousands) enrolled in grades K–12 for those states and the District of Columbia. The computer printout under the plot shows the results of fitting a straight line to the data by the method of least squares.



The regression equation is
Teachers = 4.49 + 0.0534 Enroll

Predictor	Coef	Stdev	t-ratio	p
Constant	4.486	2.025	2.22	0.031
Enroll	0.053401	0.001692	31.57	0.000

s = 10.67 R-sq = 95.3%

a. Find the correlation coefficient for the relationship between the number of teachers and the student enrollment based on these data.

b. Provide an interpretation of the slope of this line in the context of these data.

c. How will the size of the correlation coefficient change if California is removed from the data set and a new correlation coefficient is calculated? (The data point for California is labeled on the scatterplot.) Explain your answer.

d. How will the size of the slope of the least squares regression line change if California is removed from the data set and a new least squares regression line is calculated? Explain your answer.

One Possible Solution to Question Number 4

a. In the case of simple linear models, the correlation coefficient is simply the square root of R^2 written as a decimal. Since the slope of the line is positive, $r = 0.976$.

b. The slope is the expected change in y per unit change in x. As enrollment increases by one unit, which is 1,000 students, the number of teachers changes by .0534 thousand, or 53.4. This tells us that, on the average, the ratio of teachers to students is 53.4 to 1,000, or about 1 to 19.

c. If California is removed from the data set, the line will swing upward and the points will fit the line much better. Thus, the correlation coefficient will increase.

d. As in part (c), if California is removed, the line will swing upward and the slope will increase. Notice that California has the effect of lowering the teacher to student ratio (or increasing the student to teacher ratio) if it is left in the data set.

The idea behind this question is to show that students should have experience in fitting lines to data and observing the effect of points that lie outside the "cloud" represented by most of the points in the scatterplot. The easiest way to do this is to use a computer program for plotting and fitting regression models, which makes it very easy to adjust the data and fit multiple models. By removing California from the data set it can be shown that the correlation coefficient increases to 0.992 and the slope increases to 0.0625.

Two Investigative Tasks

1. About 40 percent of the mathematicians in the United States are women. A company has 11 mathematicians on its staff and only 3 are women. The president of the company, who knows little about statistics, has asked you if this can reasonably be attributed to chance.

   You decide to answer the president's question using simulation. You will use the Table of Random Digits to simulate the situation of hiring 11 randomly selected mathematicians (and counting the number of women hired).

   Note: A Table of Random Digits will be provided as a part of any question on the examination where it is needed.

   a. Describe how you will use the table to perform one trial of your simulation. Include a description of what each of the digits 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9 will represent in your simulation.
   b. Perform your simulation 20 times. Start at the left most digit in the first row of the table and move across. Make your procedure clear so that someone can follow what you did. You must do this by marking directly on or above the table.
   c. Place the results of your 20 simulations in a frequency table that shows the number of women mathematicians hired.
   d. Based on your frequency table, estimate the probability that there are 3 or fewer women in a randomly selected group of 11 mathematicians.
   e. Based on your simulation, write a report to the president of the company.

One Possible Solution to Task Number 1

a. Since about 40 percent of the mathematicians are women, I will let digits 0, 1, 2, and 3 represent women. The remaining digits will represent men. I will select 11 digits from the random digit table and count the number of digits that are 0, 1, 2, and 3. This number represents the number of women selected out of a random sample of 11 mathematicians.

b. Starting at the left of the first line of the table below and working across, out of the first eleven digits, only one represents a woman. That digit is the first underlined 3. I will continue in this way with nineteen more groups of 11 digits. The groups are separated by slash marks. The number of digits that represent women is written above each group.

	1		4		6	
48747	76595	3/2588	38392	84/422	80016	378/90
5		5			3	
71950	2249/4	00369	61269/	87073	73694	9/7751
3		8		6		4
17857	52/352	21392	229/30	43776	1050/3	58249
		5		5		4
80993/	52010	88856	2/3882	73613	57/648	47051
	5		4			4
630/16	73572	2268/4	02409	37565/	52457	01257
	6		6		2	
4/0615	63910	09/596	10241	034/13	77576	7487/2
6						
57431	29251/	77848	98037	81230	38561	69580
06181	97842	48327	37976	81333	10264	77769

c.

Number of Women	Frequency
0	
1	1
2	1
3	2
4	5
5	5
6	5
7	
8	1

d. From this frequency table, the estimated probability that there are 3 or fewer women in a randomly selected group of 11 mathematicians is 4/20 or 20 percent.

e. Dear President of the Company:

Forty percent of the mathematicians in the United States are women. Your company has hired 11 mathematicians. If these mathematicians were hired by random selection, one would expect 40 percent of them or 4.4 to be women. But your company has only 3 women mathematicians. There are many reasons why this might be the case, including discrimination against women and including different qualifications of the men and women in the pool of applicants. But there is another possible reason. I have investigated whether or not the fact you have only 3 women mathematicians could reasonably be attributed to chance. After all, you couldn't have hired *exactly* 4.4 women. You could reasonably have expected to get 4 or 5 women. Is 3 also reasonable?

I simulated the situation of hiring 11 mathematicians under the assumption that the hiring was made randomly from a pool with 40 percent women. In 4 of my 20 simulations, 3 or fewer women were hired. That is, one could expect to get 3 or fewer women about 20 percent of the time if hires were made randomly from a pool with 40 percent women. In other words, out of every five companies that hire 11 mathematicians by selecting randomly, one would expect one of the companies to get 3 or fewer women. However, it will have to be your executive decision whether or not you think that the result in your company can reasonably be attributed to chance or whether you should look for some other cause.

CALCULUS AB

		1986		1987	
	Examination Grade	Number of Students	%	Number of Students	%
Extremely well qualified	5	6,676	16.44	37	18.50
Well qualified	4	9,164	22.57	28	14.00
Qualified	3	11,766	28.98	68	34.00
Possibly qualified	2	7,095	17.47	35	17.50
No recommendation	1	5,904	14.54	32	16.00
Total Number of Students		40,605		200	
Mean Grade		3.09		3.02	
Standard Deviation		1.28		1.32	
Number of Schools		4,275		Not Available	
Number of Colleges		1,207		Not Available	

2. The table shown above provides information about the scores on the 1986 and 1987 Calculus AB Examinations. The data for 1986 were obtained from all students who took the exam. The data for 1987 were obtained from a random sample of 200 students. The data from this sample will be used to predict the performance of all students who took the 1987 Calculus AB examination.

   a. Do these data provide evidence of a change in the distribution of grades from 1986 to 1987? Give an appropriate statistical justification to support your conclusion.
   b. Is there evidence that there is a change in the mean grade from 1986 to 1987? Give appropriate statistical evidence to support your conclusion.

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One Possible Solution to Task Number 2

a. Let the null hypothesis be that the distribution of grades is the same in 1987 as it was in 1986.

Grade	Observed in 1987 Sample: O	Expected in 1987 Sample: E	$\frac{(O-E)^2}{E}$
5	37	32.88	0.516
4	28	45.14	6.508
3	68	57.96	1.739
2	35	34.94	0.000
1	32	29.08	0.293
Total	200	200	$\chi^2 = 9.06$

From the chart with 4 degrees of freedom and 5 percent level of significance, the critical value of χ^2 is 9.49. The *p*-value is between .05 and .10. This indicates there is borderline evidence that the distribution of 1987 grades differs from the distribution of 1986 grades. The difference appears to be that there are fewer grade 4's in 1987.

b. The 95 percent confidence interval for the mean grade of all Calculus AB papers in 1987 is

$$3.02 \pm 1.96\left(\frac{1.32}{\sqrt{200}}\right) = 3.02 \pm 0.18,$$

$$= (2.84, 3.20)$$

No, there is no statistical evidence of a change in the mean grade. The mean grade for all 1986 examinations was 3.09. Since this mean is in the confidence interval above, we cannot reject the possibility that the mean grade for all of the 1987 papers will turn out to be 3.09. In other words, if the mean for all of the 1987 papers is really 3.09, the same as in 1986, it would not be unlikely to get a mean of 3.02 in a sample of 200 examinations from 1987.

Answer Key to Multiple-Choice Questions

1–A, 2–E, 3–C, 4–B, 5–A, 6–E, 7–A, 8–D, 9–E, 10–D, 11–E, 12–B, 13–B

Colleges Reporting Use of AP Grades

Within the United States

In their responses to the College Board's Annual Survey of Colleges, 1995, and other inquiries, the following colleges and universities have reported that they *normally* use Advanced Placement Examination grades in the determination of advanced placement and credit, or one of these, in the field treated in this booklet. Fuller descriptions of these and other institutions' Advanced Placement policies can be obtained from the institutions themselves.

Abilene Christian University (TX)
Adirondack Community College (NY)
Agnes Scott College (GA)
Alabama Agricultural and Mechanical University (AL)
Alabama Southern Community College (AL)
Alabama State University (AL)
Alaska Pacific University (AK)
Albany College of Pharmacy (NY)
Albertus Magnus College (CT)
Albion College (MI)
Albright College (PA)
Alderson-Broaddus College (WV)
Alexandria Technical College (MN)
Alfred University (NY)
Allegheny College (PA)
Allentown College of St. Francis de Sales (PA)
Alma College (MI)
Alpena Community College (MI)
Alvernia College (PA)
Ambassador University (TX)
American International College (MA)
American River College (CA)
American University (DC)
American University in Cairo (Arab Republic of Egypt)
American University of Paris (France)
Anderson College (SC)
Anderson University (IN)
Andrews University (MI)
Angelo State University (TX)
Anne Arundel Community College (MD)
Anoka-Ramsey Community College (MN)
Antelope Valley College (CA)
Antioch College (OH)
Antioch Southern California at Santa Barbara (CA)
Appalachian State University (NC)
Aquinas College (MI)
Arapahoe Community College (CO)
Arizona State University (AZ)
Arizona Western College (AZ)
Arkansas State University (AR)
Arlington Baptist College (TX)
Art Center College of Design (CA)
Asbury College (KY)
Ashland Community College (KY)
Ashland University (OH)
Assumption College (MA)
Atlantic Union College (MA)
Auburn University (AL)
Auburn University at Montgomery (AL)
Augsburg College (MN)
Augustana College (IL)
Augustana College (SD)
Aurora University (IL)
Austin College (TX)
Austin Community College (MN)
Austin Peay State University (TN)
Averett College (VA)
Avila College (MO)
Azusa Pacific University (CA)
Babson College (MA)
Baldwin-Wallace College (OH)
Ball State University (IN)
Barber-Scotia College (NC)
Barnard College (NY)
Barry University (FL)
Barton College (NC)
Bates College (ME)
Bay Path College (MA)
Baylor University (TX)
Becker College: Leicester Campus (MA)
Belhaven College (MS)
Bellarmine College (KY)
Belmont Abbey College (NC)
Belmont University (TN)
Beloit College (WI)
Bemidji State University (MN)
Benedictine College (KS)

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Berea College (KY)
Berklee College of Music (MA)
Berry College (GA)
Bethany College (KS)
Bethany College (WV)
Bethany Lutheran College (MN)
Bethel College (IN)
Bethel College (KS)
Bethel College (TN)
Bethune-Cookman College (FL)
Big Bend Community College (WA)
Biola University (CA)
Birmingham-Southern College (AL)
Black Hills State University (SD)
Bloomfield College (NJ)
Bloomsburg University of Pennsylvania (PA)
Bluefield College (VA)
Bluffton College (OH)
Boise State University (ID)
Bossier Parish Community College (LA)
Boston College (MA)
Boston Conservatory (MA)
Boston University (MA)
Bowdoin College (ME)
Bowie State University (MD)
Bowling Green State University (OH)
Bradley University (IL)
Brandeis University (MA)
Brenau University (GA)
Brescia College (KY)
Brevard College (NC)
Brevard Community College (FL)
Brewton-Parker College (GA)
Briarcliffe: The College for Business and Technology (NY)
Bridgewater College (VA)
Bridgewater State College (MA)
Brigham Young University (UT)
Broward Community College (FL)
Brown University (RI)
Brunswick College (GA)
Bryant College (RI)
Bryn Mawr College (PA)
Bucknell University (PA)
Buena Vista College (IA)
Butler County Community College (PA)
Cabrillo College (CA)
Cabrini College (PA)
Caldwell College (NJ)
California Baptist College (CA)
California College of Arts and Crafts (CA)
California Institute of the Arts (CA)
California Lutheran University (CA)
California Maritime Academy (CA)
California Polytechnic State University: San Luis Obispo (CA)
California State Polytechnic University: Pomona (CA)
California State University: Bakersfield (CA)
California State University: Chico (CA)
California State University: Dominguez Hills (CA)
California State University: Fresno (CA)
California State University: Fullerton (CA)
California State University: Hayward (CA)
California State University: Long Beach (CA)
California State University: Los Angeles (CA)
California State University: Northridge (CA)
California State University: Sacramento (CA)
California State University: San Bernardino (CA)
California State University: San Marcos (CA)
California State University: Stanislaus (CA)
California University of Pennsylvania (PA)
Calvary Bible College (MO)
Calvin College (MI)
Cameron University (OK)
Campbell University (NC)
Campbellsville College (KY)
Canisius College (NY)
Cape Cod Community College (MA)
Capital University (OH)
Capitol College (MD)
Cardinal Stritch College (WI)
Carleton College (MN)
Carroll College (MT)
Carroll College (WI)
Carson-Newman College (TN)
Carthage College (WI)
Case Western Reserve University (OH)
Castleton State College (VT)
Catawba College (NC)
Catholic University of America (DC)
Cayuga County Community College (NY)
Cazenovia College (NY)
Cedar Crest College (PA)
Cedarville College (OH)
Centenary College (NJ)
Centenary College of Louisiana (LA)
Central College (IA)
Central College (KS)
Central Connecticut State University (CT)
Central Florida Community College (FL)
Central Lakes College (MN)
Central Michigan University (MI)
Central Missouri State University (MO)
Central Oregon Community College (OR)
Central Texas College (TX)
Central Virginia Community College (VA)
Central Washington University (WA)
Centralia College (WA)
Centre College (KY)
Cerro Coso Community College (CA)
Chabot College (CA)
Chaffey Community College (CA)
Champlain College (VT)
Chapman University (CA)
Charles R. Drew University: College of Allied Health (CA)
Chatham College (PA)

Chattahoochee Valley Community College (AL)
Chemeketa Community College (OR)
Chestnut Hill College (PA)
Christendom College (VA)
Christian Heritage College (CA)
Christopher Newport University (VA)
The Citadel (SC)
Citrus College (CA)
City College of San Francisco (CA)
City Colleges of Chicago: Malcolm X College (IL)
City Colleges of Chicago: Olive-Harvey College (IL)
City University of New York: Baruch College (NY)
City University of New York: Borough of Manhattan Community College (NY)
City University of New York: Brooklyn College (NY)
City University of New York: College of Staten Island (NY)
Clackamas Community College (OR)
Claremont McKenna College (CA)
Clarion University of Pennsylvania (PA)
Clark University (MA)
Clarke College (IA)
Clarkson University (NY)
Clemson University (SC)
Cleveland Community College (NC)
Cleveland Institute of Art (OH)
Cleveland State University (OH)
Coastal Carolina University (SC)
Coastline Community College (CA)
Coe College (IA)
Cogswell College North (WA)
Cogswell Polytechnical College (CA)
Coker College (SC)
Colby College (ME)
Colby-Sawyer College (NH)
Colgate University (NY)
College of the Albemarle (NC)
College of the Atlantic (ME)
College of Charleston (SC)
College of the Desert (CA)
College of DuPage (IL)
College of Eastern Utah (UT)
College of Great Falls (MT)
College of the Holy Cross (MA)
College of Lake County (IL)
College for Lifelong Learning (NH)
College Misericordia (PA)
College of Mount St. Joseph (OH)
College of Mount St. Vincent (NY)
College of New Rochelle (NY)
College of Notre Dame (CA)
College of Notre Dame of Maryland (MD)
College of the Redwoods (CA)
College of St. Benedict (MN)
College of St. Elizabeth (NJ)
College of St. Francis (IL)
College of St. Rose (NY)
College of St. Scholastica (MN)
College of San Mateo (CA)
College of the Sequoias (CA)
College of the Siskiyous (CA)
College of the Southwest (NM)
College of William and Mary (VA)
Collin County Community College District (TX)
Colorado Christian University (CO)
Colorado College (CO)
Colorado Institute of Art (CO)
Colorado School of Mines (CO)
Colorado State University (CO)
Columbia Bible College (SC)
Columbia College (IL)
Columbia College (MO)
Columbia College (SC)
Columbia College of Nursing (WI)
Columbia University: Columbia College (NY)
Columbia University: School of Engineering and Applied Science (NY)
Columbia University: School of General Studies (NY)
Columbia-Greene Community College (NY)
Columbus College (GA)
Columbus Technical Institute (GA)
Commonwealth College (VA)
Community College of the Air Force (AL)
Community College of Allegheny County: Allegheny Campus (PA)
Community College of Allegheny County: Boyce Campus (PA)
Community College of Allegheny County: North Campus (PA)
Community College of Allegheny County: South Campus (PA)
Community College of Philadelphia (PA)
Community College of Southern Nevada (NV)
Concord College (WV)
Concordia College (MI)
Concordia College (NE)
Concordia College (OR)
Concordia College: Moorhead (MN)
Concordia Lutheran College (TX)
Concordia University (CA)
Concordia University (IL)
Concordia University Wisconsin (WI)
Connecticut College (CT)
Contra Costa College (CA)
Converse College (SC)
Cooper Union (NY)
Cornell College (IA)
Cornell University (NY)

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Cornerstone College and Grand Rapids Baptist Seminary (MI)
Corning Community College (NY)
Cosumnes River College (CA)
Cottey College (MO)
County College of Morris (NJ)
Covenant College (GA)
Crafton Hills College (CA)
Craven Community College (NC)
Creighton University (NE)
Cuesta College (CA)
Culver-Stockton College (MO)
Cuyahoga Community College: Eastern Campus (OH)
Cuyahoga Community College: Metropolitan Campus (OH)
Cuyahoga Community College: Western Campus (OH)
Cypress College (CA)
Daemen College (NY)
Dakota Wesleyan University (SD)
Dallas Baptist University (TX)
Dana College (NE)
Daniel Webster College (NH)
Dartmouth College (NH)
Davenport College of Business (MI)
David Lipscomb University (TN)
Davidson County Community College (NC)
Davis and Elkins College (WV)
Daytona Beach Community College (FL)
De Anza College (CA)
De Paul University (IL)
Dean College (MA)
DeKalb Technical Institute (GA)
Del Mar College (TX)
Delaware County Community College (PA)
Delaware Valley College (PA)
Delta College (MI)
Denison University (OH)
DePauw University (IN)
Diablo Valley College (CA)
Dickinson College (PA)
Dickinson State University (ND)
Dillard University (LA)
Dixie College (UT)
Doane College (NE)
Dodge City Community College (KS)
Dominican College of San Rafael (CA)
Dordt College (IA)
Dowling College (NY)
Drake University (IA)
Drew University (NJ)
Drury College (MO)
Duke University (NC)
Dundalk Community College (MD)
Duquesne University (PA)
Dutchess Community College (NY)
Dyke College (OH)
D'Youville College (NY)
Earlham College (IN)
East Carolina University (NC)
East Central Community College (MS)
East Texas State University (TX)
Eastern Arizona College (AZ)
Eastern College (PA)
Eastern Connecticut State University (CT)
Eastern Illinois University (IL)
Eastern Mennonite University (VA)
Eastern Michigan University (MI)
Eastern New Mexico University (NM)
Eastern Oklahoma State College (OK)
Eastern Oregon State College (OR)
Eastern Washington University (WA)
Eastern Wyoming College (WY)
Eastfield College (TX)
Eckerd College (FL)
Edgewood College (WI)
Edinboro University of Pennsylvania (PA)
Edison Community College (FL)
El Paso Community College (TX)
Elizabeth City State University (NC)
Elizabethtown College (PA)
Elizabethtown Community College (KY)
Elmhurst College (IL)
Elmira College (NY)
Elms College (MA)
Elon College (NC)
Emerson College (MA)
Emmanuel College (GA)
Emmanuel College (MA)
Emory and Henry College (VA)
Emory University (GA)
Emporia State University (KS)
Erskine College (SC)
Essex Community College (MD)
Eugene Lang College/New School for Social Research (NY)
Evangel College (MO)
Evergreen State College (WA)
Evergreen Valley College (CA)
Fairfield University (CT)
Fairleigh Dickinson University (NJ)
Fairleigh Dickinson University: Edward Williams College (NJ)
Fairmont State College (WV)
Faith Baptist Bible College and Theological Seminary (IA)
Fashion Institute of Design and Merchandising (CA)
Fashion Institute of Design and Merchandising: San Francisco (CA)
Faulkner University (AL)
Fayetteville State University (NC)
Feather River College (CA)
Ferris State University (MI)
Ferrum College (VA)
Fisher College (MA)

Fitchburg State College (MA)
Five Towns College (NY)
Flagler College (FL)
Florence-Darlington Technical College (SC)
Florida Agricultural and Mechanical University (FL)
Florida Atlantic University (FL)
Florida College (FL)
Florida Institute of Technology (FL)
Florida Keys Community College (FL)
Florida Southern College (FL)
Florida State University (FL)
Foothill College (CA)
Fordham University (NY)
Fort Hays State University (KS)
Fort Lewis College (CO)
Framingham State College (MA)
Francis Marion University (SC)
Franciscan University of Steubenville (OH)
Franklin College (IN)
Franklin College: Switzerland (Switzerland)
Franklin and Marshall College (PA)
Franklin University (OH)
Frederick Community College (MD)
Freed-Hardeman University (TN)
Fresno City College (CA)
Fresno Pacific College (CA)
Frostburg State University (MD)
Fullerton College (CA)
Fulton-Montgomery Community College (NY)
Furman University (SC)
Gainesville College (GA)
Gallaudet University (DC)
Gannon University (PA)
Garrett Community College (MD)
Gaston College (NC)
Gateway Community College (AZ)
Gavilan Community College (CA)
Genesee Community College (NY)
Geneva College (PA)
George Fox College (OR)
George Mason University (VA)
George Washington University (DC)
Georgetown College (KY)
Georgia Baptist College of Nursing (GA)
Georgia College (GA)
Georgia Institute of Technology (GA)
Georgia Southern University (GA)
Georgia State University (GA)
Georgian Court College (NJ)
Gettysburg College (PA)
Glendale Community College (AZ)
Gogebic Community College (MI)
Golden Gate University (CA)
Goldey-Beacom College (DE)
Gonzaga University (WA)
Gordon College (GA)
Gordon College (MA)
Goshen College (IN)
Goucher College (MD)
Grace Bible College (MI)
Graceland College (IA)
Grand Rapids Community College (MI)
Grand Valley State University (MI)
Grand View College (IA)
Grantham College of Engineering (LA)
Greensboro College (NC)
Greenville College (IL)
Greenville Technical College (SC)
Grinnell College (IA)
Grossmont Community College (CA)
Grove City College (PA)
Guilford College (NC)
Gulf Coast Community College (FL)
Gustavus Adolphus College (MN)
Gwynedd-Mercy College (PA)
Hagerstown Junior College (MD)
Hamline University (MN)
Hampden-Sydney College (VA)
Hampshire College (MA)
Hanover College (IN)
Harcum College (PA)
Harding University (AR)
Hardin-Simmons University (TX)
Harford Community College (MD)
Harrisburg Area Community College (PA)
Hartwick College (NY)
Harvard and Radcliffe Colleges (MA)
Harvey Mudd College (CA)
Hastings College (NE)
Haverford College (PA)
Hawaii Pacific University (HI)
Heidelberg College (OH)
Henderson Community College (KY)
Henderson State University (AR)
Hendrix College (AR)
Henry Ford Community College (MI)
Herkimer County Community College (NY)
High Point University (NC)
Highline Community College (WA)
Hilbert College (NY)
Hillsborough Community College (FL)
Hillsdale College (MI)
Hinds Community College (MS)
Hiwassee College (TN)
Hobart and William Smith Colleges (NY)
Hobe Sound Bible College (FL)
Hollins College (VA)
Holy Family College (PA)
Holy Names College (CA)
Hood College (MD)
Hope College (MI)
Hopkinsville Community College (KY)
Houghton College (NY)

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Houston Baptist University (TX)
Howard Community College (MD)
Howard Payne University (TX)
Humboldt State University (CA)
Humphreys College (CA)
Huntingdon College (AL)
Huntington College (IN)
Husson College (ME)
Idaho State University (ID)
Illinois Benedictine College (IL)
Illinois College (IL)
Illinois Institute of Technology (IL)
Illinois State University (IL)
Illinois Valley Community College (IL)
Illinois Wesleyan University (IL)
Immaculata College (PA)
Imperial Valley College (CA)
Indian River Community College (FL)
Indiana University Bloomington (IN)
Indiana University Northwest (IN)
Indiana University-Purdue University Indianapolis (IN)
Institute of Design and Construction (NY)
Inter American University of Puerto Rico: Arecibo Campus (PR)
Inter American University of Puerto Rico: Metropolitan Campus (PR)
Inter American University of Puerto Rico: San German Campus (PR)
Iona College (NY)
Iowa State University (IA)
Itasca Community College: Arrowhead Region (MN)
Ithaca College (NY)
Jacksonville State University (AL)
Jacksonville University (FL)
James H. Faulkner State Community College (AL)
James Madison University (VA)
James Sprunt Community College (NC)
Jamestown College (ND)
Jamestown Community College (NY)
Jamestown Community College: Olean (NY)
Jefferson Community College (KY)
Jefferson State Community College (AL)
Jersey City State College (NJ)
John A. Logan College (IL)
John Brown University (AR)
John Carroll University (OH)
John F. Kennedy University (CA)
John Tyler Community College (VA)
John Wood Community College (IL)
Johns Hopkins University (MD)
Johnson Bible College (TN)
Johnson C. Smith University (NC)
Johnson County Community College (KS)
Johnston Community College (NC)
Joliet Junior College (IL)
Juniata College (PA)
Kalamazoo College (MI)
Kansas Newman College (KS)
Kansas State University (KS)
Kean College of New Jersey (NJ)
Kellogg Community College (MI)
Kendall College (IL)
Kendall College of Art and Design (MI)
Kennesaw State College (GA)
Kent State University: Stark Campus (OH)
Kent State University: Tuscarawas Campus (OH)
Kentucky State University (KY)
Kentucky Wesleyan College (KY)
Kenyon College (OH)
Keuka College (NY)
Keystone College (PA)
Kilian Community College (SD)
King College (TN)
King's College (PA)
Kings River Community College (CA)
Kirkwood Community College (IA)
Kirtland Community College (MI)
Knox College (IL)
Kutztown University of Pennsylvania (PA)
La Roche College (PA)
La Salle University (PA)
La Sierra University (CA)
Laboratory Institute of Merchandising (NY)
Lake City Community College (FL)
Lake Erie College (OH)
Lake Forest College (IL)
Lake Superior State University (MI)
Lakeland College (WI)
Lakeland Community College (OH)
Lake-Sumter Community College (FL)
Lakewood Community College (MN)
Lamar University—Beaumont (TX)
Lancaster Bible College (PA)
Lander University (SC)
Landmark College (VT)
Las Positas College (CA)
Lassen College (CA)
Lawrence Technological University (MI)
Lawrence University (WI)
Le Moyne College (NY)
Lebanon Valley College of Pennsylvania (PA)
Lee College (TX)
Lees-McRae College (NC)
Lehigh Carbon Community College (PA)
Lehigh University (PA)

Lenoir Community College (NC)
Lenoir-Rhyne College (NC)
Lesley College (MA)
LeTourneau University (TX)
Lewis & Clark College (OR)
Lexington Community College (KY)
Liberty University (VA)
Limestone College (SC)
Lincoln Memorial University (TN)
Lincoln University (MO)
Lincoln University (PA)
Lindenwood College (MO)
Lindsey Wilson College (KY)
Linfield College (OR)
Linn-Benton Community College (OR)
Lock Haven University of Pennsylvania (PA)
Long Beach City College (CA)
Long Island University: Brooklyn Campus (NY)
Long Island University: Southampton College (NY)
Longview Community College (MO)
Longwood College (VA)
Loras College (IA)
Los Angeles City College (CA)
Los Angeles Pierce College (CA)
Los Angeles Trade and Technical College (CA)
Los Angeles Valley College (CA)
Los Medanos College (CA)
Louisiana State University and Agricultural and Mechanical College (LA)
Louisiana State University in Shreveport (LA)
Louisiana Tech University (LA)
Lower Columbia College (WA)
Loyola College in Maryland (MD)
Loyola Marymount University (CA)
Loyola University (LA)
Loyola University of Chicago (IL)
Lurleen B. Wallace State Junior College (AL)
Luther College (IA)
Lutheran College of Health Professions (IN)
Lycoming College (PA)
Lynchburg College (VA)
Lyndon State College (VT)
Lyon College (AR)
Macalester College (MN)
MacMurray College (IL)
Macon College (GA)
Madisonville Community College (KY)
Madonna University (MI)
Maharishi International University (IA)
Maine College of Art (ME)
Maine Maritime Academy (ME)
Malone College (OH)
Manatee Community College (FL)
Manchester College (IN)
Manhattan College (NY)
Mankato State University (MN)
Manor Junior College (PA)
Mansfield University of Pennsylvania (PA)
Maria College (NY)
Marian College of Fond du Lac (WI)
Marietta College (OH)
Marist College (NY)
Marquette University (WI)
Mars Hill College (NC)
Marshall University (WV)
Martin Luther College (MN)
Mary Washington College (VA)
Maryland Institute College of Art (MD)
Marylhurst College (OR)
Marymount College (CA)
Marymount College (NY)
Marymount Manhattan College (NY)
Marymount University (VA)
Maryville College (TN)
Marywood College (PA)
Massachusetts College of Art (MA)
Massachusetts Institute of Technology (MA)
Massachusetts Maritime Academy (MA)
Master's College (CA)
Mater Dei College (NY)
Maysville Community College (KY)
Mayville State University (ND)
McGill University (Canada)
McHenry County College (IL)
McKendree College (IL)
McMurry University (TX)
Memorial University of Newfoundland (Canada)
Memphis College of Art (TN)
Mendocino College (CA)
Menlo College (CA)
Merced College (CA)
Mercer University (GA)
Mercy College (NY)
Mercyhurst College (PA)
Meredith College (NC)
Meridian Community College (MS)
Merrimack College (MA)
Mesa Community College (AZ)
Messiah College (PA)
Methodist College (NC)
Metropolitan State College of Denver (CO)
Miami University: Hamilton Campus (OH)
Miami University: Middletown Campus (OH)
Miami University: Oxford Campus (OH)
Michigan State University (MI)
Michigan Technological University (MI)
Mid Michigan Community College (MI)
MidAmerica Nazarene College (KS)
Middle Georgia College (GA)
Middle Tennessee State University (TN)
Middlebury College (VT)
Middlesex Community College (MA)

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Millersville University of Pennsylvania (PA)
Milligan College (TN)
Millikin University (IL)
Mills College (CA)
Milwaukee School of Engineering (WI)
Minot State University (ND)
MiraCosta College (CA)
Mississippi College (MS)
Mississippi Delta Community College (MS)
Mississippi Gulf Coast Community College: Jackson County Campus (MS)
Mississippi Gulf Coast Community College: Jefferson Davis Campus (MS)
Mississippi Gulf Coast Community College: Perkinston (MS)
Mississippi State University (MS)
Mississippi University for Women (MS)
Missouri Southern State College (MO)
Missouri Valley College (MO)
Missouri Western State College (MO)
Moberly Area Community College (MO)
Mohawk Valley Community College (NY)
Molloy College (NY)
Monmouth College (IL)
Monmouth College (NJ)
Monroe Community College (NY)
Monroe County Community College (MI)
Montana State University-Billings (MT)
Montana State University-Bozeman (MT)
Montana State University-Northern (MT)
Montana Tech of The University of Montana (MT)
Montclair State University (NJ)
Monterey Peninsula College (CA)
Montserrat College of Art (MA)
Moody Bible Institute (IL)
Moorhead State University (MN)
Moraine Valley Community College (IL)
Moravian College (PA)
Morehead State University (KY)
Morgan State University (MD)
Mott Community College (MI)
Mount Holyoke College (MA)
Mount Hood Community College (OR)
Mount Olive College (NC)
Mount St. Mary College (NY)
Mount St. Mary's College (CA)
Mount St. Mary's College (MD)
Mount San Jacinto College (CA)
Mount Vernon Nazarene College (OH)
Mount Wachusett Community College (MA)
Mountain Empire Community College (VA)
Muhlenberg College (PA)
Murray State University (KY)
Napa Valley College (CA)
Nash Community College (NC)
Nashville State Technical Institute (TN)
Nassau Community College (NY)
National College (SD)
National University (CA)
Naugatuck Valley Community-Technical College (CT)
Nazareth College of Rochester (NY)
Nebraska Wesleyan University (NE)
Neumann College (PA)
New College of California (CA)
New England College (NH)
New Hampshire College (NH)
New Hampshire Technical Institute (NH)
New Jersey Institute of Technology (NJ)
New Mexico Highlands University (NM)
New Mexico Institute of Mining and Technology (NM)
New Mexico Junior College (NM)
New Mexico Military Institute (NM)
New Mexico State University (NM)
New School of Art and Architecture (CA)
New York Institute of Technology (NY)
New York State College of Ceramics at Alfred University (NY)
New York University (NY)
Newberry College (SC)
Niagara County Community College (NY)
Niagara University (NY)
Nicholls State University (LA)
Nichols College (MA)
Nicolet Area Technical College (WI)
North Carolina Agricultural and Technical State University (NC)
North Carolina Central University (NC)
North Carolina School of the Arts (NC)
North Carolina State University (NC)
North Carolina Wesleyan College (NC)
North Central Bible College (MN)
North Central College (IL)
North Country Community College (NY)
North Dakota State College of Science (ND)
North Florida Junior College (FL)
North Georgia College (GA)
North Greenville College (SC)
North Harris Montgomery Community College District (TX)

North Idaho College (ID)
North Park College (IL)
Northampton County Area Community College (PA)
Northeast Alabama Community College (AL)
Northeast Louisiana University (LA)
Northeast Missouri State University (MO)
Northeastern Illinois University (IL)
Northeastern Junior College (CO)
Northeastern University (MA)
Northern Arizona University (AZ)
Northern Essex Community College (MA)
Northern Illinois University (IL)
Northern Kentucky University (KY)
Northern Michigan University (MI)
Northern State University (SD)
Northern Virginia Community College (VA)
Northland College (WI)
Northland Community College (MN)
Northwest Christian College (OR)
Northwest College (WA)
Northwest Missouri State University (MO)
Northwestern College (MN)
Northwestern Connecticut Community-Technical College (CT)
Northwestern Oklahoma State University (OK)
Northwestern State University (LA)
Northwestern University (IL)
Northwood University (MI)
Norwich University (VT)
Nova Southeastern University (FL)
Oak Hills Bible College (MN)
Oakland University (MI)
Oakton Community College (IL)
Oberlin College (OH)
Occidental College (CA)
Odessa College (TX)
Oglethorpe University (GA)
Ohio Dominican College (OH)
Ohio Northern University (OH)
Ohio State University Agricultural Technical Institute (OH)
Ohio State University: Columbus Campus (OH)
Ohio State University: Lima Campus (OH)
Ohio State University: Mansfield Campus (OH)
Ohio State University: Marion Campus (OH)
Ohio State University: Newark Campus (OH)
Ohio University (OH)
Ohio Valley College (WV)
Ohio Wesleyan University (OH)
Ohlone College (CA)
Okaloosa-Walton Community College (FL)
Oklahoma Christian University of Science and Arts (OK)
Oklahoma City Community College (OK)
Oklahoma City University (OK)
Oklahoma State University (OK)
Oklahoma State University: Oklahoma City (OK)
Old Dominion University (VA)
Onondaga Community College (NY)
Orange Coast College (CA)
Oregon State University (OR)
Orlando College (FL)
Otero Junior College (CO)
Otis College of Art and Design (CA)
Otterbein College (OH)
Ouachita Baptist University (AR)
Our Lady of the Lake University of San Antonio (TX)
Oxford College of Emory University (GA)
Pace University (NY)
Pacific Christian College (CA)
Pacific Union College (CA)
Pacific University (OR)
Paducah Community College (KY)
Palm Beach Atlantic College (FL)
Palm Beach Community College (FL)
Palomar College (CA)
Panola College (TX)
Park College (MO)
Parsons School of Design (NY)
Pasadena City College (CA)
Pasco-Hernando Community College (FL)
Patten College (CA)
Paul Smith's College (NY)
Peace College (NC)
Pearl River Community College (MS)
Pellissippi State Technical Community College (TN)
Pembroke State University (NC)
Penn State Erie Behrend College (PA)
Penn State University Park Campus (PA)
Pennsylvania College of Technology (PA)
Pepperdine University (CA)
Peru State College (NE)
Pfeiffer College (NC)
Philadelphia College of Bible (PA)
Philadelphia College of Pharmacy and Science (PA)
Philadelphia College of Textiles and Science (PA)
Phillips University (OK)
Piedmont Technical College (SC)
Piedmont Virginia Community College (VA)
Pierce College (WA)
Pikeville College (KY)
Pine Manor College (MA)
Pitzer College (CA)
Plymouth State College of the University System of New Hampshire (NH)
Point Loma Nazarene College (CA)
Point Park College (PA)

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Polytechnic University (NY)
Polytechnic University: Long Island Campus (NY)
Pomona College (CA)
Portland State University (OR)
Potomac State College of West Virginia University (WV)
Prairie View A&M University (TX)
Pratt Institute (NY)
Presbyterian College (SC)
Prince George's Community College (MD)
Princeton University (NJ)
Principia College (IL)
Providence College (RI)
Purdue University (IN)
Queens College (NC)
Quincy University (IL)
Quinnipiac College (CT)
Radford University (VA)
Ramapo College of New Jersey (NJ)
Randolph-Macon College (VA)
Reed College (OR)
Regis College (MA)
Regis University (CO)
Rensselaer Polytechnic Institute (NY)
Research College of Nursing (MO)
Rhode Island College (RI)
Rhode Island School of Design (RI)
Rhodes College (TN)
Richard Stockton College of New Jersey (NJ)
Richland Community College (IL)
Richmond College, The American International University in London (United Kingdom)
Richmond Community College (NC)
Ricks College (ID)
Rider University (NJ)
Ringling School of Art and Design (FL)
Ripon College (WI)
Riverside Community College (CA)
Roane State Community College (TN)
Roanoke College (VA)
Robert Morris College (PA)
Roberts Wesleyan College (NY)
Rochester Community College (MN)
Rochester Institute of Technology (NY)
Rock Valley College (IL)
Rockford College (IL)
Rockhurst College (MO)
Rocky Mountain College of Art & Design (CO)
Rollins College (FL)
Rosary College (IL)
Rosemont College (PA)
Russell Sage College (NY)
Rutgers, The State University of New Jersey: Camden College of Arts and Sciences (NJ)
Rutgers, The State University of New Jersey: College of Engineering (NJ)
Rutgers, The State University of New Jersey: College of Nursing (NJ)
Rutgers, The State University of New Jersey: College of Pharmacy (NJ)
Rutgers, The State University of New Jersey: Cook College (NJ)
Rutgers, The State University of New Jersey: Douglass College (NJ)
Rutgers, The State University of New Jersey: Livingston College (NJ)
Rutgers, The State University of New Jersey: Mason Gross School of the Arts (NJ)
Rutgers, The State University of New Jersey: Newark College of Arts and Sciences (NJ)
Rutgers, The State University of New Jersey: Rutgers College (NJ)
Rutgers, The State University of New Jersey: University College Camden (NJ)
Rutgers, The State University of New Jersey: University College New Brunswick (NJ)
Rutgers, The State University of New Jersey: University College Newark (NJ)
Sacramento City College (CA)
Sacred Heart University (CT)
Saddleback College (CA)
Sage Junior College of Albany (NY)
St. Ambrose University (IA)
St. Andrews Presbyterian College (NC)
St. Anselm College (NH)
St. Bonaventure University (NY)
St. Charles Borromeo Seminary-Overbrook (PA)
St. Charles County Community College (MO)
St. Edward's University (TX)
St. Francis College (NY)
St. Francis College (PA)
St. Hyacinth College and Seminary (MA)
St. John Fisher College (NY)
St. John Vianney College Seminary (FL)
St. John's University (MN)
St. Joseph's College (IN)
St. Joseph's College (ME)
St. Joseph's College (NY)
St. Joseph's University (PA)
St. Lawrence University (NY)
St. Leo College (FL)
St. Louis Christian College (MO)
St. Louis College of Pharmacy (MO)
St. Louis University (MO)
St. Martin's College (WA)
St. Mary College (KS)
St. Mary's College of California (CA)
St. Mary's College of Maryland (MD)

St. Mary's University of Minnesota (MN)
St. Michael's College (VT)
St. Norbert College (WI)
St. Peter's College (NJ)
St. Thomas University (FL)
St. Vincent College (PA)
St. Xavier University (IL)
Saint Mary's College (IN)
Salem College (NC)
Salem State College (MA)
Salem-Teikyo University (WV)
Salisbury State University (MD)
Salt Lake Community College (UT)
Salve Regina University (RI)
Samford University (AL)
Samuel Merritt College (CA)
San Diego City College (CA)
San Diego Mesa College (CA)
San Diego Miramar College (CA)
San Diego State University (CA)
San Francisco Art Institute (CA)
San Francisco Conservatory of Music (CA)
San Francisco State University (CA)
San Joaquin Delta College (CA)
San Jose City College (CA)
San Jose State University (CA)
Sandhills Community College (NC)
Santa Barbara City College (CA)
Santa Clara University (CA)
Santa Fe Community College (FL)
Santa Monica College (CA)
Santa Rosa Junior College (CA)
Sarah Lawrence College (NY)
Schenectady County Community College (NY)
School of the Art Institute of Chicago (IL)
School of Visual Arts (NY)
School of Visual Arts: Savannah (GA)
Schoolcraft College (MI)
Schreiner College (TX)
Scripps College (CA)
Seattle Pacific University (WA)
Seattle University (WA)
Seminole Community College (FL)
Seton Hall University (NJ)
Seton Hill College (PA)
Shenandoah University (VA)
Shepherd College (WV)
Sheridan College (WY)
Shippensburg University of Pennsylvania (PA)
Shorter College (GA)
Siena College (NY)
Simmons College (MA)
Simon Fraser University (Canada)
Simpson College (CA)
Simpson College (IA)
Sinclair Community College (OH)
Skagit Valley College (WA)
Skidmore College (NY)
Skyline College (CA)
Slippery Rock University of Pennsylvania (PA)
Smith College (MA)
Solano Community College (CA)
Somerset Community College (KY)
Sonoma State University (CA)
South Carolina State University (SC)
South Dakota School of Mines and Technology (SD)
South Dakota State University (SD)
South Georgia College (GA)
South Mountain Community College (AZ)
South Puget Sound Community College (WA)
Southeast Community College (KY)
Southeast Missouri State University (MO)
Southeastern Bible College (AL)
Southeastern Illinois College (IL)
Southeastern Oklahoma State University (OK)
Southern Arkansas University (AR)
Southern California College (CA)
Southern California Institute of Architecture (CA)
Southern College of Seventh-day Adventist (TN)
Southern College of Technology (GA)
Southern Illinois University at Carbondale (IL)
Southern Illinois University at Edwardsville (IL)
Southern Methodist University (TX)
Southern Oregon State College (OR)
Southern State Community College (OH)
Southern Utah University (UT)
Southern Vermont College (VT)
Southern Virginia College (VA)
Southern Wesleyan University (SC)
Southside Virginia Community College (VA)
Southwest Baptist University (MO)
Southwest Mississippi Community College (MS)
Southwest Missouri State University (MO)
Southwest Texas State University (TX)
Southwestern College (CA)
Southwestern Oklahoma State University (OK)
Southwestern University (TX)
Spartanburg Methodist College (SC)
Spelman College (GA)
Spokane Community College (WA)
Spokane Falls Community College (WA)
Spring Arbor College (MI)
Spring Hill College (AL)

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Springfield College (MA)
Springfield Technical Community College (MA)
Stanford University (CA)
State University of New York at Binghamton (NY)
State University of New York at Buffalo (NY)
State University of New York at Purchase (NY)
State University of New York at Stony Brook (NY)
State University of New York College of Agriculture and Technology at Cobleskill (NY)
State University of New York College of Agriculture and Technology at Morrisville (NY)
State University of New York College at Brockport (NY)
State University of New York College at Buffalo (NY)
State University of New York College at Cortland (NY)
State University of New York College of Environmental Science and Forestry (NY)
State University of New York College at Fredonia (NY)
State University of New York College at Geneseo (NY)
State University of New York College at New Paltz (NY)
State University of New York College at Old Westbury (NY)
State University of New York College at Oneonta (NY)
State University of New York College at Plattsburgh (NY)
State University of New York College at Potsdam (NY)
State University of New York College of Technology at Alfred (NY)
State University of New York College of Technology at Canton (NY)
State University of New York College of Technology at Delhi (NY)
State University of New York College of Technology at Farmingdale (NY)
State University of New York Health Science Center at Syracuse (NY)
State University of New York Maritime College (NY)
State University of New York at Oswego (NY)
Stephen F. Austin State University (TX)
Stetson University (FL)
Stonehill College (MA)
Stratton College (WI)
Suffolk County Community College (NY)
Suffolk University (MA)
Surry Community College (NC)
Susquehanna University (PA)
Swarthmore College (PA)
Sweet Briar College (VA)
Syracuse University (NY)
Tabor College (KS)
Taft College (CA)
Tallahassee Community College (FL)
Tarleton State University (TX)
Taylor University (IN)
Temple Junior College (TX)
Temple University (PA)
Tennessee Technological University (TN)
Tennessee Temple University (TN)
Tennessee Wesleyan College (TN)
Texas A&M University (TX)
Texas A&M University at Galveston (TX)
Texas Christian University (TX)
Texas Lutheran College (TX)
Texas Tech University (TX)
Texas Wesleyan University (TX)
Thiel College (PA)
Thomas College (GA)
Thomas Edison State College (NJ)
Thomas Jefferson University: College of Allied Health Sciences (PA)
Tiffin University (OH)
Toccoa Falls College (GA)
Tompkins-Cortland Community College (NY)
Tougaloo College (MS)
Touro College (NY)
Towson State University (MD)
Transylvania University (KY)
Trenton State College (NJ)
Trevecca Nazarene College (TN)
Tri-County Community College (NC)
Tri-County Technical College (SC)
Trident Technical College (SC)
Trinity Christian College (IL)
Trinity College (DC)
Trinity College (IL)
Trinity International University (FL)
Tri-State University (IN)
Triton College (IL)
Trocaire College (NY)
Troy State University (AL)
Truett-McConnell College (GA)
Tufts University (MA)
Tulane University (LA)
Tulsa Junior College (OK)
Tyler Junior College (TX)
Ulster County Community College (NY)
Umpqua Community College (OR)
Union College (KY)
Union College (NY)
Union University (TN)

United States Air Force Academy (CO)
United States International University (CA)
United States Military Academy (NY)
Unity College (ME)
University of Akron (OH)
University of Alabama (AL)
University of Alabama at Birmingham (AL)
University of Alabama at Birmingham: Walker College (AL)
University of Alabama in Huntsville (AL)
University of Alaska Anchorage (AK)
University of Alaska Fairbanks (AK)
University of Arizona (AZ)
University of Arkansas (AR)
University of Arkansas at Little Rock (AR)
University of Arkansas at Monticello (AR)
University of the Arts (PA)
University of Bridgeport (CT)
University of California: Berkeley (CA)
University of California: Davis (CA)
University of California: Irvine (CA)
University of California: Los Angeles (CA)
University of California: Riverside (CA)
University of California: San Diego (CA)
University of California: San Francisco (CA)
University of California: Santa Barbara (CA)
University of California: Santa Cruz (CA)
University of Central Florida (FL)
University of Central Oklahoma (OK)
University of Chicago (IL)
University of Cincinnati: Raymond Walters College (OH)
University of Colorado at Boulder (CO)
University of Colorado at Colorado Springs (CO)
University of Colorado at Denver (CO)
University of Connecticut (CT)
University of Dayton (OH)
University of Delaware (DE)
University of Denver (CO)
University of Dubuque (IA)
University of Evansville (IN)
University of Findlay (OH)
University of Florida (FL)
University of Hartford (CT)
University of Hawaii at Hilo (HI)
University of Hawaii at Manoa (HI)
University of Houston (TX)
University of Illinois at Chicago (IL)
University of Illinois at Urbana-Champaign (IL)
University of Indianapolis (IN)
University of Iowa (IA)
University of Judaism (CA)
University of Kansas (KS)
University of Kentucky (KY)
University of La Verne (CA)
University of Louisville (KY)
University of Maine (ME)
University of Maine at Augusta (ME)
University of Maine at Farmington (ME)
University of Mary Hardin-Baylor (TX)
University of Maryland: Baltimore County (MD)
University of Maryland: College Park (MD)
University of Maryland: Eastern Shore (MD)
University of Maryland: University College (MD)
University of Massachusetts Boston (MA)
University of Massachusetts Dartmouth (MA)
University of Memphis (TN)
University of Miami (FL)
University of Michigan (MI)
University of Michigan: Dearborn (MI)
University of Michigan: Flint (MI)
University of Minnesota: Crookston (MN)
University of Minnesota: Duluth (MN)
University of Minnesota: Twin Cities (MN)
University of Mississippi (MS)
University of Missouri: Columbia (MO)
University of Missouri: Kansas City (MO)
University of Missouri: Rolla (MO)
University of Mobile (AL)
University of Montana-Missoula (MT)
University of Montevallo (AL)
University of Nebraska Medical Center (NE)
University of Nebraska—Lincoln (NE)
University of Nevada: Las Vegas (NV)
University of Nevada: Reno (NV)
University of New Hampshire (NH)
University of New Hampshire at Manchester (NH)
University of New Haven (CT)
University of New Mexico (NM)
University of New Orleans (LA)
University of North Carolina at Asheville (NC)
University of North Carolina at Chapel Hill (NC)
University of North Carolina at Charlotte (NC)
University of North Carolina at Greensboro (NC)

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University of North Carolina at Wilmington (NC)
University of North Dakota (ND)
University of North Dakota: Williston (ND)
University of North Florida (FL)
University of North Texas (TX)
University of Northern Colorado (CO)
University of Northern Iowa (IA)
University of Notre Dame (IN)
University of Oklahoma (OK)
University of Oregon (OR)
University of the Pacific (CA)
University of Pennsylvania (PA)
University of Pittsburgh (PA)
University of Pittsburgh at Bradford (PA)
University of Pittsburgh at Greensburg (PA)
University of Pittsburgh at Johnstown (PA)
University of Pittsburgh at Titusville (PA)
University of Portland (OR)
University of Puerto Rico: Arecibo Campus (PR)
University of Puerto Rico: Mayaguez Campus (PR)
University of Puerto Rico: Ponce Technological University College (PR)
University of Puget Sound (WA)
University of Redlands (CA)
University of Rhode Island (RI)
University of Richmond (VA)
University of Rio Grande (OH)
University of Rochester (NY)
University of St. Thomas (MN)
University of San Diego (CA)
University of San Francisco (CA)
University of Scranton (PA)
University of the South (TN)
University of South Alabama (AL)
University of South Carolina (SC)
University of South Carolina at Spartanburg (SC)
University of South Carolina at Union (SC)
University of South Dakota (SD)
University of South Florida (FL)
University of Southern California (CA)
University of Southern Indiana (IN)
University of Southern Maine (ME)
University of Southern Mississippi (MS)
University of Southwestern Louisiana (LA)
University of Tampa (FL)
University of Tennessee: Chattanooga (TN)
University of Tennessee: Knoxville (TN)
University of Tennessee: Martin (TN)
University of Texas at Arlington (TX)
University of Texas at Austin (TX)
University of Texas at Dallas (TX)
University of Toledo (OH)
University of Tulsa (OK)
University of Vermont (VT)
University of Virginia (VA)
University of Washington (WA)
University of West Alabama (AL)
University of Wisconsin Center-Baraboo/Sauk County (WI)
University of Wisconsin Center-Manitowoc County (WI)
University of Wisconsin Center-Marathon County (WI)
University of Wisconsin Center-Marinette County (WI)
University of Wisconsin Center-Sheboygan County (WI)
University of Wisconsin Center-Washington County (WI)
University of Wisconsin-Eau Claire (WI)
University of Wisconsin-Green Bay (WI)
University of Wisconsin-Madison (WI)
University of Wisconsin-Milwaukee (WI)
University of Wisconsin-Oshkosh (WI)
University of Wisconsin-Parkside (WI)
University of Wisconsin-Platteville (WI)
University of Wisconsin-River Falls (WI)
University of Wisconsin-Stevens Point (WI)
University of Wisconsin-Stout (WI)
University of Wisconsin-Superior (WI)
University of Wisconsin-Whitewater (WI)
University of Wyoming (WY)
Urbana University (OH)
Ursinus College (PA)
Utah State University (UT)
Utah Valley State College (UT)
Utica College of Syracuse University (NY)
Valdosta State University (GA)
Valencia Community College (FL)
Valley Forge Christian College (PA)
Valley Forge Military College (PA)
Valparaiso University (IN)
Vance-Granville Community College (NC)
Vanderbilt University (TN)
Vassar College (NY)
Ventura College (CA)
Vermont Technical College (VT)

Vernon Regional Junior College (TX)
Villa Maria College of Buffalo (NY)
Villanova University (PA)
Vincennes University (IN)
Virginia Commonwealth University (VA)
Virginia Highlands Community College (VA)
Virginia Intermont College (VA)
Virginia Military Institute (VA)
Virginia Polytechnic Institute and State University (VA)
Virginia Wesleyan College (VA)
Viterbo College (WI)
Volunteer State Community College (TN)
Wabash College (IN)
Wagner College (NY)
Wake Forest University (NC)
Waldorf College (IA)
Walla Walla College (WA)
Wallace State College at Hanceville (AL)
Warner Pacific College (OR)
Warner Southern College (FL)
Warren County Community College (NJ)
Wartburg College (IA)
Washburn University of Topeka (KS)
Washington College (MD)
Washington and Jefferson College (PA)
Washington State University (WA)
Washington University (MO)
Washtenaw Community College (MI)
Wayne Community College (NC)
Wayne State College (NE)
Wayne State University (MI)
Waynesburg College (PA)
Weber State University (UT)
Webster University (MO)
Wellesley College (MA)
Wells College (NY)
Wenatchee Valley College (WA)
Wentworth Institute of Technology (MA)
Wentworth Military Academy (MO)
Wesley College (DE)
Wesleyan College (GA)
West Chester University of Pennsylvania (PA)
West Liberty State College (WV)
West Shore Community College (MI)
West Virginia Institute of Technology (WV)
West Virginia Northern Community College (WV)
West Virginia University (WV)
West Virginia Wesleyan College (WV)
Westchester Business Institute (NY)
Western Baptist College (OR)
Western Carolina University (NC)
Western Connecticut State University (CT)
Western Illinois University (IL)
Western Kentucky University (KY)
Western Maryland College (MD)
Western Michigan University (MI)
Western Montana College of the University of Montana (MT)
Western Nebraska Community College: Scottsbluff Campus (NE)
Western New England College (MA)
Western Oregon State College (OR)
Western State College of Colorado (CO)
Western Texas College (TX)
Western Washington University (WA)
Western Wyoming Community College (WY)
Westfield State College (MA)
Westminster College (MO)
Westminster College of Salt Lake City (UT)
Westmont College (CA)
Wharton County Junior College (TX)
Whatcom Community College (WA)
Wheaton College (IL)
Wheaton College (MA)
Wheeling Jesuit College (WV)
Wheelock College (MA)
Whittier College (CA)
Whitworth College (WA)
Wichita State University (KS)
Wilkes Community College (NC)
Willamette University (OR)
William Jewell College (MO)
William Paterson College of New Jersey (NJ)
William Rainey Harper College (IL)
William Woods University (MO)
Williams Baptist College (AR)
Williams College (MA)
Willmar Community College (MN)
Wilmington College (OH)
Wilson College (PA)
Wingate College (NC)
Winona State University (MN)
Winston-Salem State University (NC)
Winthrop University (SC)
Wisconsin Lutheran College (WI)
Wittenberg University (OH)
Wofford College (SC)
Woodbury University (CA)
Worcester Polytechnic Institute (MA)
Wright State University (OH)
Wytheville Community College (VA)
Xavier University (OH)
Xavier University of Louisiana (LA)
Yakima Valley Community College (WA)
Yale University (CT)

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Yeshiva University (NY)
York College of
Pennsylvania (PA)
Youngstown State
University (OH)
Yuba College (CA)

Canadian Colleges and Universities

Acadia University
Bishop's University
Carleton University*
Concordia University
McGill University
Memorial University of
Newfoundland
Mount Allison University†
Mount St. Vincent
University
Okanagan University
College
St. Francis Xavier†
St. Mary's University‡
Simon Fraser University
Trinity Western University
University of Alberta
University of British
Columbia
University of Calgary
University of Guelph†
University of Manitoba
University of New
Brunswick
University of Northern
British Columbia
University of Regina
University of Victoria
University of Winnipeg
York University†

* Qualifying year only.
† Contact Admissions for subject list.
‡ Placement by individual assessment.

Colleges Reporting Use of AP Grades

Outside the United States

Many colleges and universities outside the United States have formal AP policies. These include 86 German universities that decided in 1992 to permit foreign secondary school graduates with grades of 3 or higher in AP German and three other specified AP courses to be admitted without further examination or course work. (Students who receive a grade of 3 or better on the AP Examination in German Language are not required to pass an additional language examination in German.) Also having AP policies are universities in Great Britain, Australia, New Zealand, France, Spain, Sweden, and Norway, to name just a few. For a complete list of non-U.S. universities and colleges with formal AP policies, please consult the booklet *AP International: Colleges and Universities with AP Policies*, available from the College Board.

AP Publications

There are a number of publications available from the AP Program; some of these are described below. For further information, please call AP Order Fulfillment at (609) 771-7243.

Please send your order to Advanced Placement Program, Dept. E-22, P.O. Box 6670, Princeton, NJ 08541-6670. Payment must accompany all orders not on institutional purchase orders, and checks should be made payable to The College Board. The College Board pays fourth-class book rate (or its equivalent) postage on all prepaid orders; you should allow 4–6 weeks for delivery. Postage will be charged on all orders requiring billing and/or requesting a faster method of shipment.

Publications may be returned within 30 days of receipt if postage is prepaid and publications are in resalable condition and still in print.

Unless otherwise specified, orders will be filled with the currently available edition. Prices are subject to change without notice.

1. AP Course Descriptions. . . $10. Each subject's course outline and content is described, along with sample multiple-choice and free-response questions (where appropriate), and resources for the course.
2. Teacher's Guides. . . $12. Suggestions and guidelines for teaching the AP course, including sample syllabi from high school and college teachers throughout the country.
3. Released Exams. . . $18. The entire AP Examination, a multiple-choice answer key, and the process and standards for scoring the free-response sections of the exam. Copies of the examination without the related materials are also offered in sets of 10 for classroom practice ($30).
4. Student Guides. . . $12. A general description of the course content, the process of grading AP Exams, and suggestions for exam preparations, written for a student audience.
5. Set of Free-Response Questions Used in the Past Five Years. . . $5.
6. *AP Bulletin for Students and Parents*. . . Free. A general description of the AP Program, including policies and procedures for preparing to take the exams, and registering for the AP courses.
7. *College Explorer*®. . . $125. An IBM-compatible computer software package that gives policies for each AP Examination, as reported by approximately 3,100 colleges.

1997 Advanced Placement Examination in Statistics
Tuesday, May 6, afternoon session

1995–96 Development Committee in Statistics

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